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ABSTRACT

This report examines a study to promote high-technology industries in British Columbia using an essentially integrated educational and economic development program. Human resources, skilled in high-technology and entrepreneurship, are recognized as prime sources of potential development of high-technology industries in the Province. An educational program integrating technological and managerial training is proposed for the development of such a resource, and is illustrated by examining the possibilities in the field of fine-chemicals and pharmaceuticals manufacturing. A model involving the "discovery park" concept working through an active cooperation between educational institution, different departments and levels of government, small-scale manufacturing units, and a cooperative-based large marketing corporation is proposed. The study suggests a number of benefits to be accrued from such a model. Finally, the proposed model is broadly examined in terms of the cost involved in its development, and some suggestions are given as to the most economical way to proceed. Appended materials include the basic proposal, a list of British Columbia and Canadian financial assistance programs, and a bibliography. (CT)

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HIGH–TECHNOLOGY INDUSTRIES THROUGH ENTREPRENEURIAL EDUCATION

A BLUEPRINT FOR DEVELOPMENT

BCIT

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D E D I C A T I O N

To those who blaze their own paths
and tend their own gardens with
dirt, dust, blood and sweat.

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PREFACE

This blueprint originates out of a conviction that the problem of developing secondary industries is basically educational in nature. With the increasing complexity of technology, business and commerce, the traditional image of an entrepreneur as one with guts hardened in the school of hard-knocks, is fast disappearing. We are now entering an era in which we need persons who can build a new structure of entrepreneurship on the technological and managerial foundations laid these last fifty years. A potential entrepreneur needs to be trained in these skills.

This problem is even more crucial in Western economies. In Canada, particularly in British Columbia - where exploitation of natural resources is the mainstay of our economy - technology of automation is reducing the number of jobs available in our primary industries. Unless this effect is counteracted by a parallel development of secondary, manufacturing industry, our socio-economic system will soon be under considerable strain.

Factors such as geographic location, low population, high labour costs, and costs involved in transporting finished goods to the markets, discourage development of cost-sensitive, consumer goods in British Columbia. Evolving high-technology industries appears to be the viable alternative. However, there are considerable difficulties in this direction also.

What follows is an examination of the problems arising out of a lack of secondary industries, an analysis of the difficulties confronting the development of high-technology industries, and a model designed to overcome these difficulties through 'entrepreneurial education' and 'discovery parks' concepts.

The proposed model is illustrated by examining fine-chemicals/pharmaceuticals as a high-technology industry. It can be applied, with equal effectiveness, to such other industries as electronics, instrumentation, communications, process controls, computers, etc.

Hopefully, this study will not only stimulate a critical examination and refinement of the proposed model, but will also develop a positive response in terms of renewed debate on such topics as: the role and responsibilities of educational institutions in promoting industrial development; the importance of a cooperative mode of education in generating new industries; the socio-economic significance and future of small-scale industries; and the possibilities of revitalising the technological promise of our land.

Above all, it is hoped that the model proposed serves as a basis for the development of secondary industries in this Province. If so, it will usher new economic and technological impetus in the Province. Also, because similar problems exist in other Canadian provinces, the results of this study can have a tremendous impact on the Nation as a whole.

April, 1979 V.M.P.

ACKNOWLEDGEMENTS

The basic concept presented in this report, together with a proposal to set up a fine-chemicals manufacturing small unit in a discovery park, was first discussed separately with the officials of the B.C. Ministry of Education, Simon Fraser University and the British Columbia Institute of Technology in the Summer of 1977. A tentative plan for a four-year, cooperative, entrepreneurial education program towards a Bachelor of Technology degree (B. Tech.) in Food-Science Management was submitted to BCIT on 29th of June 1977 (Appendix 7.1). Since then, the BCIT administration and the Board of Governors have moved rapidly to accept the concept of cooperative education, and of the B. Tech. degree. Establishment of a discovery park on a site across from BCIT also appears to be headed toward reality.

The author cannot help but feel deeply gratified in seeing these developments, and sincerely acknowledges the encouragement through these events initiated by the Ministry, and by the Board and Administration of BCIT. In particular, I am most grateful to Hon. Dr. Patrick L. McGeer and Dr. Walter Hardwick - the Minister and the Deputy Minister respectively of Education, Science and Technology in the Government of British Columbia.

They got the idea off dead center, not only by financially supporting this study (and the earlier one on Cooperative Education - BCIT April 1978), but, in fact, by pushing me into it after reading my initial brief. Their vision and personal interest in the project has been a source of constant inspiration.

The central concept of this project received many positive suggestions, constructive criticism, apathetic disregard as well as outright cynicism from many with whom I had informal discussions. All these individuals, in their own way, have helped me in refining the original model. My thanks to countless many who listened and reacted the way they did! Special thanks to Jim Caldwell, Russ Curtis, Brian Gillespie, Dave Martin and Drug Svetic - all from BCIT - who rendered considerable help in preparing this report.

April, 1979 V.M.P.

BRIEF SUMMARY

The economic principle of 'Comparative Advantage' suggests that the growth of high-technology manufacturing industries is a possible solution to the problem of developing secondary industries in British Columbia. Such a development is not only economically feasible but is also environmentally and socially desirable. The objective of this study is to promote high-technology industries in British Columbia using an essentially integrated educational and economic development program.

Human resource, skilled in high-technology and entrepreneurship, is recognized as a prime source of potential development of high-technology industries in the Province. An educational program integrating technological and managerial training is proposed for the development of such a resource, and is illustrated by examining the possibilities in the field of fine-chemicals and pharmaceuticals manufacturing.

A model involving the 'discovery park' concept working through an active cooperation between educational institution, different departments and levels of government, small-scale manufacturing units, and a cooperative-based large marketing corporation is proposed. The study suggests a number of benefits to be accrued from such a model.

Finally, the proposed model is broadly examined in terms of the costs involved in its development, and some suggestions are given as to the most economical way to proceed.

1. EXECUTIVE SUMMARY

1.1 PURPOSE

Development of secondary manufacturing industries in British Columbia depends largely on the availability of human resources, skilled in both high technology and entrepreneurship. Through the last 14 years, B.C.I.T. has successfully trained graduates in technologies suitable for primary industries, business and government agencies. The institute is now seeking to include a degree granting status. It is therefore appropriate that at this point we now consider offering programs which will promote secondary industries in the province as a part of our role in setting new directions for high technology.

The purpose of this study is to suggest a plan of development enabling BCIT to offer programs to potential entrepreneurs, which will integrate training in high-technology and business administration. It is believed that such a program will promote the development of skill-oriented, small-scale, high-technology industries in British Columbia.

1.2 OBJECTIVE

The long range objective of this study is to promote development of secondary industries in British Columbia using an essentially educational approach. The immediate objective is to recommend to

the BCIT administration, and through them to the Board of Governors and the Ministry of Education, Science and Technology, a plan for the introduction of an integrated educational and economic development program.

1.3 SCOPE

While the field of secondary manufacturing industries is diverse, this study is restricted to educational programs which will promote small-scale, skill-intensive, high-technology industries in British Columbia. The definition of the term 'entrepreneurial education' is therefore restricted to only those programs which integrate applied science training with modern management training so that the graduates of the program could become entrepreneurs by starting small-scale, skill-intensive, high-technology ventures of their own, thereby creating jobs rather than seeking jobs in existing corporate structures.

A high-technology industry is defined as that which manufactures products which require advanced production-skills, are relatively insensitive to costs, and which have a high ratio of production and marketing costs to the costs of transportation to available markets.

The recommendations in this report have Province-wide applicability. In fact, the basic concept developed could be gainfully used in any region of the country. Thus, although this study proposes

the developments at BCIT, the Ministry of Education, Science and Technology may decide to develop such programs at any other institution in the Province.

1.4 RECOMMENDATIONS

1. That the Government of British Columbia consider the development of high-technology industries as environmentally, economically and socially desirable in the Province and encourage their growth jointly through the Ministry of Education, Science and Technology (MEST), and the Ministry of Economic Development (MED).

2. That the British Columbia Institute of Technology (BCIT) evolve into a degree-granting technological university known as the British Columbia University of Technology (BCUT).

3 That BCUT undertake an integrated educational and economic development program to promote technological innovations and high-technology industries in the Province, and request joint funding from MEST and MED to create a 'Division of Entrepreneurship'. This Division would:

   a. Evolve four-year, degree-granting, entrepreneurial education programs designed to generate skill-oriented, small-scale, high-technology industries, and patterned after the model proposed in this study.

   b. Initiate negotiations with the Provincial Government and the British Columbia Development Corporation (BCDC) to develop a 'discovery park' on the property across from BCIT on the east side of the Willingdon Avenue.

c. Provide facilities for the entrepreneurial education students to receive on-the-job experience during their studentship, and post-graduation support to prepare feasibility studies and business plans for launching new enterprises.

d. Provide continued long-term support to the discovery park industries and maintain liaison with outside industries and government agencies.

2. INTRODUCTION

Two events, which occurred during the winter of 1978, may prove to be of considerable significance to the development of technological and innovative capabilities in British Columbia. They may also prove to be important in evolving secondary industries in the Province. These events were: (i) The Ministry of Education in B.C. changed its portfolio from 'education only' to 'education, science and technology'. And (ii), the Board of Governors of BCIT passed an enabling motion to seek the status of a four-year, degree-granting, polytechnic.

In seeking the new status, the Board adopted a statement of definition and role for the polytechnic (Appendix 7.2). In its new role, BCIT is to:

a. concentrate on programs which focus on the applied sciences of management, engineering, health, including inter-disciplinary training in these areas.

b. contribute to the technological advancement of B.C. through the utilization of the human and technological resources of the Polytechnic in cooperation with such appropriate agencies as discovery park industries, and through applied research.

c. evolve programs which will provide a balance of applied theory and skills through study on campus, complemented by supervised educational experience in industry and business, through such activities as cooperative education, and/or equivalent work-experience.

The purpose, objective and the scope of the present study to develop 'Manufacturing Industries-Related Entrepreneurial Education' is in accord with the above-stated role of BCIT as well as with the recent change in ministerial portfolio.

2.1 DEFINITION OF ENTREPRENEURIAL EDUCATION

An effective educational system reflects the complexity of a contemporary society. To remain effective, our educational institutions today must equip our youth with skills which will enable them to cope with the complexity of the modern technological society. Technology - the application of science in industry and commerce - is in a pivotal position in the latter half of this century. Its detractors hold it responsible for a variety of contemporary problems; its supporters point to positive innovations; while all agree as to its essential role in shaping our society.

With the advent of technology, business and commerce has also become increasingly complex. Today, the success of an individual in a small business venture, depends mostly on specific skills both in scientific as well as business techniques. Competence in the scientific fields or in the business procedures alone can no longer be regarded as 'adequate' in the modern complex world of business and industry. An entrepreneur of a century ago was a person with the ability to organize a business he himself could run, control and embrace. Now we are entering an era in which we need people who can build a new structure

of entrepreneurship on managerial and technological foundations laid these last fifty years.

If the reality of new entrepreneurship is to be reflected in our educational system, programs which integrate training in applied science with modern management procedures, should be developed at post-secondary levels. Two approaches are traditionally used to provide students with a combination of technical and business knowledge. These are:

i) MBA Approach: Graduates in various disciplines - technical as well as non-technical - take two years of common, formal training towards a Master's degree in business administration.

ii) Single Course Approach: Engineering seniors and professionals (continuing education) are taught business skills in a single course on entrepreneurship.

In reality such 'add-on' approaches, while being highly useful to those seeking employment in existing business and industries, rarely encourage graduates to launch new manufacturing ventures. Consequently these are not truly entrepreneurial education programs. Such programs, of course, are not necessarily designed with an objective of training aspring entrepreneurs.

A third approach, which integrates technical and business skills, is described in the next section. However, its emphasis is on

small businesses such as service industries, retail trade, etc. rather than on manufacturing.

For the purpose of the present study we have focused our attention exclusively on the secondary* manufacturing industries and therefore define entrepreneurial education more precisely as:

> Entrepreneurial education programs are those which integrate applied science training with modern management techniques so that the graduates of such a program may become entrepreneurs by starting skill-intensive, small-scale, technology-based industries.

2.2 HISTORICAL DEVELOPMENT

In the recent years, some studies have appeared (bibliography) recommending or describing educational programs for small-business entrepreneurship. In British Columbia, the Vancouver Community College has recently started a program in Small Business Development. This One-Year, Certificate Program emphasizes service industries, retail trade, wholesale & agency activities, and simple manufacturing operations (handicrafts, etc.). The concept of cooperative education is incorporated in the program by dividing the training period into eight months of on-the-campus instructions and four months of on-the-job experience.

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*According to the Economic Council of Canada, Living Together: A Study of Regional Disparities, Supply and Services Canada, Ottawa, 1977, p. 64, the production sector of economy is defined as primary and secondary industries and non-production is equivalent to "tertiary";

Primary:	Agriculture, fishing, forestry, mining, trapping, etc.
Secondary:	Manufacturing, utilities, construction, transport, communications, etc.
Tertiary:	Trade, finance, insurance, real estate, public administration, defence and other services, etc.

Several colleges in the United States, notably The Berea College, Berea, Kentucky, and Oak Wood College, Huntsville, Alabama, have been offering small-business oriented entrepreneurial education programs for more than fifty years. However, the objectives of such programs are: "To provide needed revenue for endowment or discretionary purposes; to broaden the college's appeal to prospective students; to supply a constant source of student aid through part-time employment opportunities; and to give students training for future careers through apprenticeships." These colleges have attempted to take the concept of cooperative education one step beyond its traditional limits by establishing auxiliary enterprises in college communities, enabling students to participate in well-directed, career-influencing apprenticeships within the institutions.

For example, the enterprises established by Berea College include,

- Hotel and Dining Room
- College Farm & Poultry
- Laundry Service
- Printing Press
- Bookstore
- Convenience Store
- Student Crafts e.g. woodcrafts, weaving, needlepoint, ceramics, lapidary, broom making, wrought iron, etc.

The manager of each enterprise is a professional with business experience while students work in supervisory and non-supervisory positions. The college provides management services, legal services, business data services and financial services.

This information about the existing entrepreneurial education programs highlights the fact that the concept developed in this report is unique in its emphasis as well as objectives, from that used traditionally. In this study, the term 'Entrepreneurial Education' is used synonymously with the term 'Manufacturing Industries-Related Education'.

2.3 IMPORTANCE OF ENTREPRENEURIAL EDUCATION TO BRITISH COLUMBIA

a. Economic Growth

On the global scene, the so called 'industrial revolution' has already entered a "third phase" of technological change. During the "first phase" of such a revolution, the economy of a region changes from 'agrarian' to the 'industrial', causing labour to move from farms to resource based industries such as mining, forestry and fishing. The "second phase" involves a transition from coal and steam based economy to that nourished by hydro-electricity, petroleum and internal combustion engine. Cheap labour and its quantitative capacity to produce resource based consumer goods marks the success of this phase. A region undergoing this transition sees concurrent growth and development in infrastructure such as roads, transportation and communications facilities. During the "third phase", scientific and technological capabilities in a region, and the quality of its labour, governs its economic growth. Labour, skilled in technology, organization, and management, is largely responsible for the production of wealth during this phase, and the demand for personnel skilled

in technologies increases.

It may be argued that the Province of British Columbia entered "phase two" of this industrial revolution during the period between 1950 and 1970. However, its entry into "phase three" will depend largely upon the capacity for foresight and perception on the part of our educational institutions and the relevant ministries of the Government.

b. Entrepreneurship and Economy

The present economy of British Columbia is based, almost entirely, on the primary industry. The most important element in the development of this kind of industry is the 'natural resources'. If these resources are available in a region, other ingredients such as finance, human resources and the technology flows into the region from the rest of the world. It is often unnecessary to have local markets for such primary products because they can be exported to the resource hungry areas of the world.

Over the past few decades, large multinationals explored and developed British Columbia's natural resources for which they initially brought in skilled manpower and technology from outside. They also developed export markets for primary products such as ore and lumber. Later on, BCIT and vocational schools were created in the Province to supply the human resources demanded by these industries and by the tertiary, service industries.

For the growth of the secondary industries, however, the most important element is the skilled human resource. If the entrepreneurial and the manufacturing skills exist in a region, secondary industries can be developed by importing raw materials and exporting finished goods to technologically less developed regions. The phenomenal rise of Japan's economy after the Second World War, and development of manufacturing industries in Britain during colonization are the prime examples of such possibilities. Though, in the early stages, relatively cheap labour may have played a role in developing the Japanese manufacturing sector, its continued strength is clearly the result of its technological capabilities. Japanese educational institutions deserve great credit for displaying the foresight and leadership in the development of a human resource skilled in entrepreneurship, and in innovation.

To the extent that the economy of B.C. depends on resource products rather than specialization of secondary manufacturing, it can be regarded only as semi-industrial and underdeveloped. Perhaps, the same terms apply to the Canadian economy as a whole. (Paul T. Davenport, Capital Accumulation and Economic Growth, Ph.D. dissertation, Department of Political Economy, University of Toronto, Toronto, 1976). Already, the number of Canadians who would endeavour to start an enterprise - a business or an industry - is on the decline. General reluctance of Canadians to launch enterprises has earned them the reputation of having

a larger per capita bank balance in savings accounts than any other people in the world.

This is an indication of our fear of enterprise, and the obvious conclusion is that our educational institutions must increasingly undertake the responsibility of removing this fear by developing entrepreneurial educational programs which will provide skills for the enterprise.

c. Manufacturing Industries and Employment

Earlier, we discussed how labour characteristics and patterns change from 'agrarian' to 'industrial' through three phases of industrial revolution. During the transition stage from 'phase two' to 'phase three', there is usually an oversupply of industrial labour force. This force is skilled and educated in primary, resource-based industrial technology as well as in non-productive, service-industry based skills.

If the growth in the manufacturing sector of economy occurs at this stage, urban employment in productive (primary & secondary) industries gradually declines while that in the non-productive (tertiary) sector slowly increases. (Fig. 1). These changes produce an inversion in the percentages of employment in productive and non-productive sectors, giving rise to, what Bell calls, "Post-Industrial Society". (Daniel Bell, The Coming of Post Industrial Society, Basic Books, New York 1973). The inversion is a result of simultaneous evolution of technology

which gives rise to increased production through automation and consequent decline in production jobs, while demand for tertiary services such as public administration and social services as well as traditional commercial and financial services gradually increases.

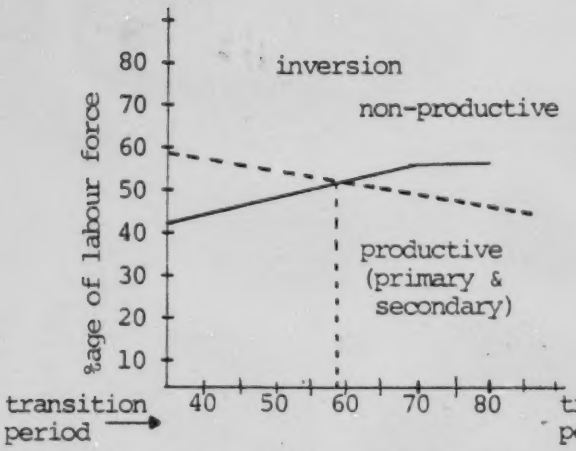

Fig.1: Urban Employment Pattern, normal inversion during transition from phase two to three.

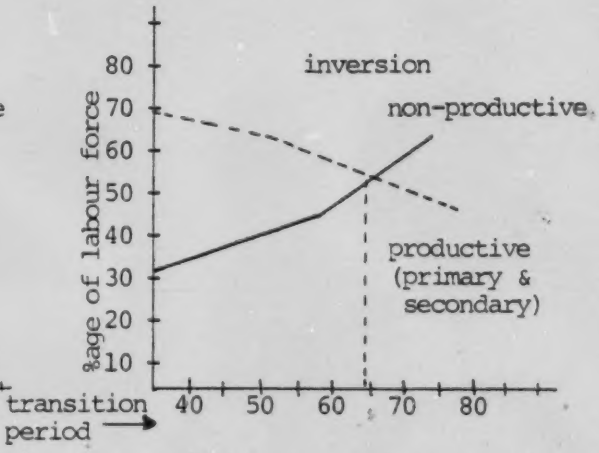

Fig.2: Urban Employment Pattern, forced inversion due to impeded growth of manufacturing.

What happens to this pattern of industrial employment if the transition from 'phase two' to 'phase three' does not occur at a normal pace? If the development of the manufacturing sector is impeded, and the transition is delayed, violent, rather than gradual, changes in employment patterns usually take place (Fig. 2). Unemployment, resulting from the lack of industrial activity, becomes a social force often compelling governments to generate employment in public and social services sector. These changes cause an artificial but sudden inversion in employment patterns, which the economy cannot comfortably accommodate.

Thus, these inversion graphs may be taken as reliable indicators of the pace of industrial revolution from 'phase two' to 'phase three' in a region. Such inversions occurred in the United States in 1959 and in Canada in 1965; however, whereas the inversion in the United States followed a smooth pattern shown in Fig. 1, that in Canada followed the violent inversion shown in Fig. 2. (Sources: United States, Bureau of the Census, Census of Population: 1970 Detailed Characteristics, Final Report United States Summary, US Government Printing Office, Washington, DC, 1973, Tables 77 and 235; Statistics Canada, 1971 Census of Canada, Vol. III, Part 5, Cat. No. 94-758, Supply and Services Canada, Ottawa, Table 7).

Although similar information for the employment patterns in British Columbia is presently unavailable, it is expected that the employment pattern in our resource-based Province will show a graph similar to Fig. 2, with perhaps even more violent rise in non-productive sector, particularly in the public administration and social services. (The recent fall of Canadian Dollar may show a temporary rise in productive sector employment due to increased exports, but this must be taken as a short-term phenomenon.)

Another employment indicator of transition is the percentage change in the professional jobs over a ten year period. In Canada (1961-1971), the increase in employment for scientists,

engineers, mathematicians and technologists has been 4.0% in the manufacturing sector as against 88.3% in services and public administration sector (including education, health, welfare, defence, etc.). In the United States (1960-1970), on the other hand, the comparable figures are 15.5% and 73% respectively. Furthermore, in Canada, the jobs for engineers and technologists increased at twice the rate for scientists in manufacturing; this probably suggests that the increased activity in the manufacturing sector was that of implementation and adaptation of existing technology, rather than development of new technology.

d. Factors Influencing the Development of Manufacturing Industry

There is a serious lack of secondary manufacturing industries in British Columbia. One of the reasons given for this lack is the geographical location of this Province. Being at the Western end of this vast country and away from the population centers of Ontario and Quebec, transportation costs for B.C. manufactured goods are often cited as prohibitive and therefore barriers in attracting secondary industries to the Province. The population base in Western Canada is also regarded as inadequate to sustain manufacturing industries here. High labour costs and the strong union movement in British Columbia are frequently blamed as major factors in discouraging manufacturing industries in the Province.

It is necessary to seriously examine the real extent of influence of such factors on the lack of development of manufacturing industries in British Columbia. Not too long ago, manufacturing industries developed rapidly in California in the face of similar factors. This development sparked a simultaneous and subsequent growth in population and technology in that state. Why is it, then, that British Columbia can not overcome similar difficulties? Furthermore, should these factors prove to be really significant in deterring the development of manufacturing industry in the Province, is it not possible to design a model that would overcome these difficulties and encourage industrialization in British Columbia? Could specially designed educational programs help us overcome some of these difficulties and develop certain types of secondary industries? If so, what could be the nature and scope of such programs and what industrial model could be designed to maximize the results from such programs?

The presence of certain socio-economic conditions is also important for the development of manufacturing industries in a region. These are:

a. Economic wealth and/or availability of venture capital.

b. Entrepreneurial spirit.

c. Human resource capable of undertaking research, development and management of technology related to the field of manufacturing. For example, pharmaceutical industry cannot develop in a region without the availability of experts

such as manufacturing pharmacists and chemists, medical researchers capable and interested in drug development, pharmaceutical marketing specialists, etc.

d. Government agencies and educational institutions capable and willing to undertake long-term planning in the development of such human resources through educational and research incentives programs.

e. An attitude on the part of government, educational institutions and private industries, that the funds appropriated for innovation, applied research, and product development represent "investment today for possible benefits tomorrow".

f. A political system consisting of representatives who enjoy enough trust from the population so that the political leaders do not have to take short-term decisions of exploiting natural resources for winning votes today, at the cost of long-term planning to develop international markets for manufactured products based on the indigenously evolved new technology.

We will see later on, that of the three types of major socio-economic conditions, viz. geographical, financial and intellectual, the last is critical in the development of manufacturing industries in British Columbia.

2.4 FURTHER STUDY

Although several factors have been identified above as important

in industrial development, a detailed study is required to assess the real extent of their influence. Such a study will truly establish the role of entrepreneurial education. Some of the points recommended for further study are:

1. What is the extent of current manufacturing activity in the Province?
2. The classification of existing secondary industries into various technological categories.
3. A survey of existing secondary industries to determine executive opinions on the strengths and weaknesses of British Columbia as a site for manufacturing activity.
4. Documentation and analysis of the extent of influence exercised by factors such as geographic location, transportation costs, labour costs and the level of technology, on an entrepreneur's decision to locate manufacturing industries in British Columbia.
5. It is generally recognized that the factors mentioned in No. 4 above do play some role in the development of manufacturing industry in a region. The extent of their influence may vary however, with the nature and type of industry. For example, industries based on exclusive know-how and high-technology may be less subject to the effects of some of the cost factors mentioned above. In assessing the importance of entrepreneurial education programs in British Columbia, it is essential that such high-technology fields be identified.

2.5 SUMMARY AND CONCLUSIONS

1. Development of 'Manufacturing Industries Related Programs' at BCIT is in accord with the stated role of BCIT in the provincial educational system, as well as with the recent change in the ministerial portfolio from The Ministry of Education to The Ministry of Education, Science, and Technology.
2. Traditionally, the use of the term "Entrepreneurial Education" is synonymous with "Small-Business Management". However, we define the term as: "A Program which integrates applied science training with modern management techniques so that the graduates of such a program can become entrepreneurs by starting skill-intensive, small-scale, high-technology based ventures of their own, thereby creating jobs rather than seeking jobs in existing corporate structures.
3. British Columbia is presumed to be continuing in 'phase two' of the three phase industrial revolution. However, its entry in the third phase has been unusually delayed due to the absence of certain socio-economic conditions - lack of entrepreneurial education being one of them.
4. The impeded development of manufacturing industries in B.C. has produced an unnatural pattern of industrial employment in the Province. This may be presently obscured due to the devalued Canadian dollar, but our economy will not be able to sustain its strain on a long-term basis.

5. Geographic location, transportation costs and high wages are often blamed as the deterrents in the development of secondary industries in B.C. However, a careful study of the real impact of these factors is required. Opportunities still exist for technology-intensive secondary industries.
6. Of the three socio-economic conditions viz. geographical, financial, and intellectual, British Columbia's industrial development depends largely on the last. Consequently, the B.C. Government - particularly the Ministry of Education, Science and Technology and the educational institutions in B.C. have a significant role to play in the industrial development of this Province.

3. TYPE OF INDUSTRY FOR BRITISH COLUMBIA

Given the geographic location and population of British Columbia, what kind of manufacturing industry can be readily developed in this Province? To be successful, an industry must be able to effectively meet a specified need of the society. If the need for the products of an industry is inadequate in its home region, the industry must seek external markets. Competition with other manufacturers in such an external region is possible only if the company has an exclusive know-how and virtual monopoly, or an ability to manufacture with high efficiency and low costs in raw materials, production, labour and transportation.

3.1 CONSUMER PRODUCTS

Many consumer products such as light or heavy appliances, furniture, automobiles, clothing, industrial chemicals, etc. do not have a large enough local demand to warrant vigorous manufacturing activity in British Columbia. This province may be an unsuitable site for such industries simply because of our low population and high costs of transportation to the Eastern Canadian markets. The nature of these industries is such that large-volume, automated, mass-production techniques are required for their successful operation, and the day has passed when our

entry into such industries was feasible. These areas are now dominated by America, Japan, Europe and some developing countries.

Such automated industries are frequently capital-intensive, and labour costs form a relatively minor component of the market value of their products. Furthermore, the greater the automation, the less is the importance of the labour-cost element in any consumer-products industry. Consequently, the relatively high cost of labour in British Columbia is unlikely to be the most important factor in a prospective manufacturer's decision to select B.C. as a site for plant location. On the other hand, in the absence of a large enough local market for such products, the costs involved in bringing parts and components to B.C., and/or transporting the finished products to Eastern markets form a very high percentage of the total cost of the finished unit. Therefore, in selecting the type of manufacturing activity for B.C., the sensitivity of the product to transportation costs must be regarded as an important, if not prime, criterion. Many, so called, 'high-technology' industries are believed to be less sensitive to transportation costs.

3.2 IMPORTANCE OF INNOVATIVE CAPABILITIES

Before we proceed to define and examine cost-sensitivity of high-technology industries, it is necessary to understand the role of innovation in industrial development. From this

viewpoint, we may classify manufacturing industries into those that are technology-dependent and others that are technology-intensive. While technology plays a crucial role in the development of both these types of industries, the difference lies in the nature and use of technology for development.

a. Technology-Dependent Industries

A technology-dependent industry uses new technology to improve its production techniques but the nature of its products remains essentially the same. For example, resource-based industries, such as pulp-industry, could and do use improved and automated production techniques to produce more and perhaps better quality pulp. However, pulp is their main product and technology is used to improve its production. A company which develops or purchases a better production technique may thereby gain advantage over its competitors.

However, knowledge and technological innovations are now rapidly diffusing throughout today's world of instant communications. A high-technology of today rapidly becomes an intermediate technology tomorrow. Therefore, unless a company has in-house arrangement for continuous development of newer production technology, and unless its home region has educational and financial environment to support such innovation, it may not be able to maintain its lead for too long.

Furthermore, this ability to maintain a technological lead is particularly crucial for industries located in a region such as B.C. where high wages, high transportation costs and low local demand are a reality. In the absence of our own innovative capacity in production technologies, even the resource-based, technology-dependent industries will lose out to the regions with lower-wage economies. In fact, the British Columbia industries had, until recently, started to gradually lose their share of world market in lumber to Australia, Brazil, Chile and New Zealand .... and market in pulp to South Africa, Argentina, Australia and Mexico. Canada, for the same reasons, no longer enjoys the lead in the world supply of copper, nickel, zinc, etc. Certainly, our inadequacy in technological innovation must share some responsibility for these losses.

b. Technology-Intensive Industries

The technology-intensive industries, on the other hand, are those which manufacture newer products developed through technological innovation. For example, whereas a pulp mill which uses advanced machines and instruments is a technology-dependent company, the engineering industry which innovates, develops and manufactures such machines and instruments is a technology-intensive industry. Although these companies might be selling machines and instruments, technology is what they are marketing. A large variety of secondary manufacturing industries fall under this category.

The ultimate success of all these industries depends on their innovative capacity because, in the final analysis, innovation and products developed through innovation is what they have to market. Needless to say that, like technology-dependent industries, these too can develop and survive only in an environment of innovation; the role of educational institutions in this can not be overstated.

3.3 HIGH TECHNOLOGY PRODUCTS

In considering the type of products suitable for secondary manufacturing in British Columbia, it is the technology-intensive industry that offers most promise because of the relative insensitivity of such products to transportation costs. In fact, for the purpose of this study, we define high-technology products as those which require high technical competence and skills of production and are characterised by a very high ratio of production and marketing costs to the costs of transportation to available markets.

Cases in point are the Swiss watch industry, and the Japanese camera and electronics industry. These industries, which were to thrive mostly on export markets, concentrated their efforts on high technology, high-quality, low-weight items such as precision watches, high-performance electronics equipment and powerful cameras. Mass produced Japanese products could compete

in the world markets only as long as cheap Japanese labour was available in the immediate post-war era. As the cost of living and with it the cost of labour went up in Japan, these cheap items were gradually displaced by high-technology products. The relative cost of transportation of such low-cost items proved to be simply too high to meet the North American competition.

Another consideration in recommending high technology industry for B.C. is a fundamental economic principle known as "The Principle of Comparative Advantage". British Columbia enjoys comparative advantage over other regions of Canada, and over many other nations in the area of resources such as lumber and minerals. We have exploited this absolute advantage by developing primary industries, and, with proper management, will continue to do so in future.

In the area of secondary industries, although we may be in a relatively disadvantaged position with regards to consumer products, our labour force, conditioned by our educational, economic, and political systems, is certainly an asset. Compared to many other nations, North American systems are capable of producing a work force which is more skilled and efficient, innovative, and readily adaptable to newer technology. We also have an economic frame-work capable of attracting highly skilled work-force from anywhere in the world. Consequently, in the field of high-technology - where quality of the work-force is the most

important prerequisite - we are in a potentially advantageous position. However, such a potential can be realised only through a carefully planned program of education and industrial incentives designed to promote high-technology industries in the Province.

Not all the products in the technology-intensive category could, however, be considered equally suitable for immediate development in British Columbia. In spite of their high technological content, some, such as paints, plastics and artificial fibre are still consumer products and must compete with other somewhat similar products in the market. Thus, these are highly cost-sensitive and dependent on local demand. In the case of air-conditioning, heating, refrigerating, rolling stock, tools and transportation equipment industry, the transportation costs for raw materials and finished products may not be low enough for B.C. to compete successfully with other regions and countries. In yet another technology-intensive industry - viz. photographic equipment - the level of world technology is perhaps too advanced for B.C. to catch up with, without the presence of even a rudimentary nucleus of such technology in the Province.

3.4 HIGH TECHNOLOGY INDUSTRY AND EDUCATIONAL INSTITUTION

It is obvious that the prerequisite for the development of high-technology industries is the work-force skilled in high-technology, and capable of continuous innovation. Such a force

must come from our own educational institutions, for it will not migrate from outside unless high-technology industries exist in the region to attract them. Consequently, our educational institutions must examine their existing programs and design new ones so that the skills in high-technology, entrepreneurship and technological innovation are promoted.

Another important factor that an educational institution must take into account in deciding upon a manufacturing industry related program is that of its effectiveness in immediately promoting a particular sector of manufacturing industry. For example, training a student in a particular manufacturing technology may be ineffective if the opportunities do not exist for the graduates to either find an immediate employment or to launch a manufacturing venture of that kind on their own. Industries such as computer manufacture, synthetic fibre, locomotive and rolling stock, etc. are of this category. They do no exist in the Province at the present time and are too capital-intensive for a fresh graduate to venture into.

Thus, the size of the industry is another criterion in considering the type of industry suitable for development in B.C. through an educational program. Only those industries which are skill-intensive, rather than capital-intensive, and consequently those which can be operated on a small-scale - mostly by owner/entrepreneurs - should be considered here. Given below is a

partial list of such industries: (products listed).

- data processing and communications equipment;
- instrumentation for analytical use in mines, scientific laboratories, industrial and environmental analysis, etc.;
- bio-medical instrumentation; electronic components & crystals;
- advanced design small aircrafts;
- control devices; and high unit cost sensors;
- artificial human organs and specialized medical supplies such as hearing aids, motorised wheel-chairs, optical frames and lenses, etc.;
- solar energy products;
- rare pharmaceutical intermediates; and pharmaceutical formulations; biochemicals;
- batch-produced, complex, research and fine chemicals;
- radio-isotopes and labelled compounds for medicinal use;
- specialized dyes, stains, food-colours, etc.;
- educational devices, etc. EVR

The foregoing is certainly not an exhaustive list. A detailed feasibility study may eliminate some of these products from the list of possibilities while identifying others to extend this list.

This recommendation of considering only the small-scale, skill-intensive, high-technology industries offers another benefit - that of the employment factor. As noted on page 13, increased

industrial activity has the ultimate effect of reducing the relative number of people in productive employment. Looking ahead, such a trend is fraught with serious sociological consequences. A planned program of building up economy through skill-intensive, small-scale, high-technology projects will not only provide significant economic wealth for the Province but will also reverse this employment trend by creating direct opportunities for skilled workers and indirect jobs for a large section of urban population.

Futhermore, whereas large industries tend to converge towards large population centers, the type of industries suggested here can provide stimulus to smaller cities in this vast Province of ours, through well-planned high-technology industrial parks. These industries are generally non-polluting, and their small size will enable them to easily blend in the skylines of many small towns in B.C. In planning an industrial strategy for this beautiful Province, the environmental factor must not be overlooked.

Thus, the development of high-technology industries may be regarded as a goal which is environmentally, economically and socially desirable as well as feasible in British Columbia.

3.5 SUMMARY AND CONCLUSIONS

1. In selecting the type of manufacturing industry for development

in B.C., the sensitivity of the product to transportation costs appears to be the prime criterion. Consequently, some consumer products manufacturing industries may not find B.C. to be a suitable site.

2. High technology industries are believed to be less cost-sensitive. For the purpose of this study, high-technology products are defined as those which require high technical competence and skills for production and which are characterized by a very high ratio of production and marketing costs to the costs of transportation to the available markets.

3. Manufacturing industries are classified as technology-dependent, and technology-intensive. While innovative skills in technology are important for both the classes, the technology-intensive industries develop essentially through the marketing of technology itself; consequently, the capacity to innovate in technological fields is a crucial factor in the development of secondary industries in B.C. The role of a technological institute in this cannot, therefore, be overstated.

4. The size of the industry is another criterion in considering the type of industrial development through education programs.

5. Several high-technology, small-scale industries are identified for possible development through an entrepreneurial education

program now considered.

6. Economic development, increased industrial employment and the possibilities of developing smaller population centers through high-technology based, small industries in industrial research parks, are cited as benefits of such an educational program.

4. THE EDUCATIONAL PROGRAM

4.1 THE BASIC CONCEPT

An educational program designed for the development of any particular manufacturing industry must equip the graduate with both the theory and the current "state of art" in that industry. In the case of high-technology industry, this includes instructions in both, the general scientific, technical and related fields as well as in specialized skills in the specific field of manufacture. To be effective, at least some of these skills must come through direct, on-the-job, supervised training and experience in the industry.

In addition, the program for potential entrepreneurs must include training in business and management skills. In the absence of such skills even the best-skilled technologist will find it impossible to embark upon any venture.

An entrepreneurial educational program related to high-technology secondary industry must therefore provide a blend of

i) fundamental basic knowledge in scientific, technical and related fields,

ii) specialized skills in the field of manufacture,

iii) on the job experience and training in the current "state of art" in the industry,

iv) business and management skills - both general and specifically related to that industry.

Making such a program available to the potential entrepreneur is only the first step in an educational institution's responsibility towards the development of a secondary industry. A second, perhaps more important, step is to provide the graduate with the much needed support during his crucial stage of launching an enterprise and piloting it through the early days of its development. An educational institution may provide such support directly through one-to-one services by its staff and faculty or indirectly through concepts and organizations such as industrial/research parks, manufacturer's asscciations, industrial development organizations and the related ministries of the Government.

The program proposed below is in two parts and suggests a strategy for developing some high-technology industries in British Columbia. This chapter describes the educational part of the program, whereas Chapter 5 deals with the post-graduation part and describes an industrial model. The concept is illustrated by considering Fine Chemicals/Pharmaceuticals industry as a typical high-technology industry. The educational program describes the course work and subject outlines to train students in this field, and the industrial model is designed to stimulate the development of a fine-chemicals industry in the Province through a 'discovery-park' concept.

4.2 THE ON-CAMPUS TRAINING

Given below is an outline of an educational program believed to be ideal and possible of development at BCIT. However, it is recognized that the recommended program may undergo modifications to accommodate wishes, ideas and aspirations of a number of individuals within and outside the Institution. Development of such a program at any other institution may similarly warrant local amendments. Nevertheless, we believe that our basic approach is sound and that the details given here will serve as guidelines to bring about further refinements.

It is possible to design similar educational packages for almost all the manufacturing industries listed in Section 3.3. Our choice of fine-chemicals/pharmaceutical industry as the model for this study is based simply upon the author's background and experience as a chemist. The first two years of this program are designed to match, as closely as possible, the two year program in the Chemical and Metallurgical Technology at BCIT with a Fine-Chemicals/Industrial Pharmacy option in the second year. Furthermore, an attempt is made to include as many as possible, the courses existing at BCIT. While some courses could be used in their present form, some may need minor modifications to make them suitable for this program. Courses not being given at BCIT are numbered 00.000.

Another important point to note is that a program of this nature cannot be designed for a large number of students. The main thrust of this study is that, "like leaders, some so-called 'born' entrepreneurs too can stand some training to improve their performance". Therefore, the proposed educational program is only for a small number of full-time students who may be admitted on the basis of their drive, innate abilities and determination to become entrepreneurs.

It is possible that some of those admitted in the program may not measure up to their pre-admission promise of potential and may want to drop out of the program while those admitted in other BCIT diploma programs may demonstrate enough promise to be admitted for the entrepreneurial education. Likewise, existing entrepreneurs may also want to update their skills through part-time - BCIT continuing education programs. Thus, any program designed for potential entrepreneurs must be flexible enough to accommodate these eventualities.

Offering specialized courses to only a small number of students may, of course, raise the question of cost-effectiveness of the program. Although higher than normal costs per student in this program may not be avoidable and may even be justifiable in terms of the ultimate economic goal of the program, some ideas of cost-reduction are recommended in Chapter 6.

a. COURSE OF STUDIES

Year 1 Term 1* (Fall)		hrs/wk	
30.101	Applied Chem. Prin	6	
31.141	Technical Communications	3	
32.141	Basic Technical Mathematics	5	
33.114	Physics	6	
41.103	Engineering Materials	3	
49.101	Drafting	2	
10.135	Economics	3	
44.122	Biology and Biochemistry	6	** Please see the note below

* The program for this term is essentially the same as that given in the first term of Chem. & Met. Technology program at B.C.I.T. except for the last two courses. These two courses replace a 4½ hr. course in Environmental Science. Perhaps an option be considered at this level.

Year 1 Term 2* (Spring)		hrs/wk
30.201	Applied Chemical Principles	6
31.110	Business Communication	3
32.241	Statistics and Calculus	5
33.214	Physics	6
41.202	Laboratory workshop	1**
30.204	Chemical Laboratory Techniques	3
41.210	Industrial Chemical Processes	3
49.201	Drafting	2
16.140	Accounting	5

* The program for this term is essentially the same as that given in the second term of Chem. & Met. Technology program at B.C.I.T. except for the following changes.
  (a) Business Communications replaces technical communications
  (b) Laboratory workshop is reduced to 1 hr. from 1½ hr.
  (c) Accounting course replaces a 3½ hr. course in Engineering Materials.

** Inclusion of some techniques in organic chemistry is recommended.

Year 1 Term 3 (Summer)

This should be a three-month Cooperative work-term with a chemical or pharmaceutical manufacturer. Other students in Chem. & Met. program, i.e. those not going for entrepreneurial education in Fine chemicals/ Industrial Pharmaceuticals program may not require work-term. Details of the work-term program are given later in section 4-

Year 2 Term 4 (Fall)

		hrs/wk
32.341	Mathematics - Numerical Methods	5
30.314	Analytical Chemistry	3*
30.310	Physical Chemistry	5
41.341	Unit Operations	6
41.320	Unit Project (Pharmaceutical or Org.)	6**
30.309	Organic Chemistry I	6
44,121	Introductory Microbiology	3***

This program is essentially the same as that for Term 3 of the Chem. & Met. Technology at B.C.I.T. except for the following changes.

* Number of hrs/wk for analytical chemistry is reduced from 6 to 3. This could be done by eliminating some ore-analysis & fire-assay theory and experiments.

** Number of hrs. increased from 3 to 6. For the students in entrepreneurial education program, this course would be a theory and practical course in Organic Synthesis or Pharmaceutics I

***Additional Course, not required for the present Chem. & Met.students

Year 2 Term 5 (Spring)

		hrs/wk
30.414	Analytical Chemistry	3*
41.441	Unit Operations	6
30.409	Organic Chemistry II	6
47.409	Process Dynamics	3
41.420	Unit Project (Pharmaceutical or Org.)	6**
10.360	Business Law	
	OR	3***
00.000	Pharmaceutical Law, Ethics & Organization	
30.416	Chemical Instrumentation	
	OR	4
98.101	Human Anatomy & Physiology	

This program is essentially the same as that for Term 4 of the Chem. & Met. Technology at B.C.I.T. except for the following changes.

* Comment same as for Term 4 above. This course should emphasize instrumental techniques in organic chemistry e.g. U.V., I.R., N.M.R., Mass Spec., Chromatography, etc.

** Comment same as for Term 4 above. Should be treated as a course in Pharmaceutics II and/or Organic Synthesis II and be a continuation of 41.320.

***Additional Course not required for present Chem. & Met. students.

Year 2 Term 6 (Summer)

A cooperative education work-term. Please see comments under term 3.

Year 3 Term 7 (Fall)

	Common	hrs/wk
16.344	Managerial Accounting	3
00.000	Pilot Plants - principles, design, operation and layout.	3
00.000	Production and Material control	3
00.000	Biochemistry	6
	Industrial Pharmacy Option	
00.000	Pharmacology I	6
00.000	Pharmaceutical Chemistry I	6
00.000	Pharmaceutical Technology I	6
	Fine Chemicals Option	
00.000	Advanced Organic Chemistry III	6
00.000	Special Project I - Feasibility Studies in Organic Synthesis	12

Year 3 Term 8 (Spring)

00.000	Chemical Economics	3
00.000	Organizational Development - how to start, finance and manage.	3
00.000	Nuclear Chemistry	6
00.000	Drug Design - Principles & Practice	3
	Industrial Pharmacy Option	
00.000	Pharmacology II	6
00.000	Pharmaceutical Chemistry II	6
00.000	Pharmaceutical Technology II	6
	Fine Chemicals Option	
00.000	Advanced Organic Chemistry IV	6
00.000	Special Project II- Continuation of Feasibility Studies in Org. Syn.	12

Year 3 Term 9 (Summer) and Year 4 Term 10 (Fall)

Cooperative Education Work-terms. Please see comments under Term 3.

Year 4 Term 11 (Spring)

00.000	Industrial Microbiology	6
00.000	Industrial Relations	3
00.000	Marketing	3
00.000	Special Project III - Feasibility Std.	20

b. Subject Outlines

Year 1 Term 1

10.135, Economics — The aim of the course is to develop an understanding of the organization and operations of the Canadian economy. Students analyse demand and supply, how production costs vary and how prices are determined in different markets (micro-economics). The theoretical tools of the economist are used to explore the concepts of national income, employment, money and banking, inflation, international trade and growth (macro-economics). An appreciation of the relation between economic theory and economic policy is provided.

30.101 Applied Chemical Principles — An applied course in basic inorganic chemistry including simple stoichiometry, solubility product, selective precipitation, solution preparation, pH, buffer solutions, oxidation-reduction, acid-base theory and titration calculations. Lab work consists of simple qualitative and quantitative analysis. Good lab techniques are emphasized.

31.141, Technical Communication — This course is designed to introduce students to the techniques and tools used in communicating technical information to people in business and industry. On completion of the two courses, students should be capable of analyzing information and designing an information package—report, proposal, letter or memo—intended for business or industrial audiences.

32.141 Basic Technical Mathematics — Topics in algebra, logarithms, trigonometry and analytic geometry.

33.114, Physics — An introductory level course covering kinematics, dynamics, function, statics, angular motion, energy, momentum, simple machines, properties of matter, fluid mechanics, temperature and heat, thermal properties of matter, basic electricity and magnetism, wave motion and sound, electromagnetic waves, optics and atomic and nuclear phenomena. The lab program stresses the subjects of measurements, data analysis, experimental technique and report writing. Mathematical treatment requires algebra and trigonometry.

41.103, Engineering Materials — Physical testing of materials including metals, plastics, wood and wood products, concrete, ceramics and soils. Non-destructive testing. Microscopy, photomicrography and photography.

44.122 Biology — A study of the principles underlying living phenomena, including the organizational attributes of living matter. Evolutionary development is traced from one-celled organisms to higher plants and animals. The economic importance of various classes of plants and animals is included.

49.101, Drafting — Techniques of reading and producing orthographic drawings using standard format and the development of basic skills in applying these techniques. Use of instruments, line work, geometric constructions, orthographic projection, isometric drawing and sketching, sections and dimensioning.

Notes:

44.122 Biology - This course also includes elementry biochemistry.

49.101 - Emphasis in this course should be on machine drawing and process design drawing.

Term 2

16.140, Accounting — Basic accounting procedures; closing the books; adjustments; working papers; merchandise operations; statement and ledger organization; special journals; forms of business organization; accounting principles; introduction to cost accounting; analysis of financial data; working capital; departmental and branch operations; consolidations.

Term 2 cont

30.201 Applied Chemical Principles — A continuation of 30.101 that includes theory of gravimetric and volumetric analysis, titration curves, chemical kinetics, simple physical chemistry, atomic structure, ionic and covalent bonding, periodicity and descriptive organic chemistry of selected groups. Lab work consists of qualitative and quantitative analysis and physical separations.

31.110, 31.210 Business Communication — Students will be instructed in the skills and techniques required to write memos, letters and reports of the kind used in business; to speak in small and large group situations; and to develop effective telephone techniques. The course begins with a brief review of the communication process and includes an organizational approach to writing and speaking tasks. The course includes modules on the job search and study skills. One lecture per week provides core information. Practical application of the material occurs in the three labs held weekly and through periodic assignments.

32.241 Statistics I and Calculus I — An introduction to statistics and calculus. The statistics portion includes organization and presentation of data; measures of central tendency and dispersion; frequency distributions; sampling; estimation; hypothesis testing. The calculus section covers applications involving the differentiation and integration of algebraic, trigonometric, logarithmic and exponential functions.

33.214 See 33.114

41.210 Industrial Chemical Processes — Description of chemical processes involved in major industrial chemical plants in B.C. Pulp and paper, oil refineries, mineral dressing, smelting, sulphuric acid, ammonia, caustic and chlorine and phenolic plants.

30.204 Chemical Laboratory Techniques — This course teaches basic techniques in sampling, weighing, moisture determination, ashing, extractions, filtration gravimetric methods and volumetric methods. Instrumental analysis and separation methods will be described, demonstrated and whenever possible, practised.

41.202 Laboratory Workshop — Instruction in basic workshop techniques, including glass blowing, soldering, brazing and gas welding techniques. Use of hand and bench tools.

49.201 See 49.101

Year 2 Term 4

30.309, 30.409 Organic Chemistry — A general course covering properties, preparations and reactions of all major classes of organic compounds—aliphatic and aromatic hydrocarbons, halides, alcohols, ethers, carboxylic acids and derivatives of carboxylic acids, aldehyes, ketones, amines, amino acids, carbohydrates, heterocyclics, dyes, and polymers. Lab work emphasises organic techniques, qualitative chemical analysis and instrumental methods, infra-red, ultraviolet and gas chromatography.

30.310 Physical Chemistry — This course presents the kinetic theory of gases, the first and second laws of thermodynamics, phase equilibria, chemical kinetics and catalysis. Lab work consolidates lecture material and gives experience in practical physio-chemical measurements.

30.314 Analytical Chemistry — Conventional inorganic methods of analysis for the determination of the common metals

32.341 Numerical Methods I — Elementary numerical methods in theory and practice; iterative methods in the solution of algebraic and transcendental equations; finite differences; interpolation; numerical differentiation and integration; numerical solution of simple differential equations.

41.320, 41.420 Unit Project — Projects relating to the student's chosen specialties are assigned in each term. Regular progress reports and a final term report are required.

41.341, 41.441 Unit Operations — First and second law of thermodynamics; enthalpy, entropy, phase rule, thermodynamic diagrams and tables; fluid flow and measurement in pipes and channels, piping, pipe fittings and valves; solid handling, grinding, crushing, screening, mixing, settling, sedimentation, filtration, flotation; flow of heat, conduction, convection, radiation, film and over-all transfer co-efficients, heat exchangers; principles and application of equipment for evaporation, distillation, absorption, extraction; humidification and dehumidification; drying, crystallization; ion exchange.

44.121 Introductory Microbiology — The course is designed to train students in the basic microbiological procedures employed in a laboratory; the use and care of the microscope; staining methods; aseptic techniques; methods of identifying micro-organisms.

Year 2 Term 5

10.360, 10.460 Business Law — A study of legal rules and principles which guide decisions involving the law of contracts, including the sale of goods and negotiable instruments, as well as the business associations of agency, partnership and the company.

30.409 See 30.309

30.414, 30.424 Analytical Chemistry — Advanced analytical techniques using various instruments such as the polarograph, spectrophotometer, colorimeter, gas chromatograph, spectrograph, x-ray scintillometer and x-ray diffractometer.

30.416 Analytical Instrumentation — This course covers the practical aspects of the following topics: chemical cells and electrodes, electrical measurements, potentiometric recorders, power supplies, operation amplifiers, recording potentiometric and amperometric titration and instrumentation in d.c. polarography.

41.420 See 41.320

41.441 See 41.341

47.409 Process Dynamics — Measurement transducers, interface devices, indicators and recorders. Controllers and control functions. Dynamics of process systems, lumped parametric solutions. Upset solutions. Computer applications of system modelling.

98.101, 98.201 Human Anatomy and Physiology — The course involves a systematic approach to the study of human anatomy and physiology for Medical Laboratory Technology students. This course includes basic cytology, and introduction to histology and the skeletal, muscular, nervous, circulatory, respiratory, digestive, urinary and reproductive systems. The primary emphasis is on the physiology of these systems. Basic biochemistry related to each system is also included.

00.000 Pharmaceutical Law, Ethics & Organization. - An overview of pharmaceutical industry, structure & purpose; regulatory affairs; food & drug regulations; R & D pre-clinical & clinical evaluations; good manufacturing practices; drug recall procedures; quality control requirements; QUAD inspection standard/procedures; marketing, labelling, advertising regulations, medical communications; enquiry handling; product surveillance; all aspects of Food & Drug Directorate regulations are examined.

Year 3 Term 7

16.344 Management Accounting — The management accountant's role; income determination; decision-making; profit planning; budget; forecasting; profit-margin variance analysis; corporate financial analysis; income tax; internal control; annual report; accounting aids for sales and production management; measuring managerial performance; direct costing and the contribution approach.

r 2 Term 5 (Spring)

Pharmaceutical Law, Ethics & Organization

An overview of pharmaceutical industry, structure and purpose; regulatory affairs; food and drug regulations, R. & D. pre-clinical and clinical evaluation, good manufacturing practices; quality control requirements; QUAD inspection standard/procedures; drug recall procedure; marketing, labelling, advertising regulations, medical communications, enquiry handling, product surveillance, all aspects of Food and Drug Directorate regulations are examined.

ar 3 Term 7 (Fall)

Pilot Plants - Principles, Design, Layout and Operation

Basic concepts, functions of a pilot plant eg. process development, evaluation of raw materials, products and by products, collecting chemical engineering data; the kind and size of pilot plant location, considerations in Universal pilot plant design eg. costs, maintenance, flexibility, safety, etc.; choice of equipment; pilot scale reactors - general considerations eg. prototype of plant model, construction material, agitation and heat transfer, pressure, charging and discharging ports, etc. Batch reactors; fixed bed and fluid bed catalytic reactors, other unit operations.

Production and Material Control

Introductory part of the course includes topics such as basic deterministic and probabilistic economic order quantity models, statistical forecasting techniques for discrete time series and production scheduling and sequencing methods.
Factors related to demand forecasting, production planning & control, & operations scheduling are evaluated & applied to the design of an integrated production control system. Using a production system simulator results from operations of the designed systems are obtained & interpreted. In addition, concepts such as dynamic programming, linear decision rules and matrix analysis of production; project management and inventory control.

3. Biochemistry

An introduction to the structure, function & metabolism of compounds in biological system; biochemical components of the various tissues of the organism and their special function; the biochemical basis of certain clinical disorders.

4. Pharmacology I & II

This course deals with pharmacodynamics, therapeutic uses and toxicity of drugs; chemotherapy, mechanism of drug action & factors influencing concentration in different parts of the organism. Biophysical and biochemical aspects are considered. Important diseases & therapeutic applications of drugs are also discussed. Laboratory part includes traditional and instrumental methods of drug analysis, bio-assays, etc.

5. Pharmaceutical Chemistry I & II

A study of physical, chemical and biological concepts as they apply to drug formulations; Factors affecting drug stability, stability testing, the prediction of shelf-life, formulation & storage of chemicals are examined through chemical kinetics; similarly, factors determining the administration, absorption, distribution, metabolism & excretion of drugs are also discussed. Laboratory part includes traditional and instrumental methods of drug isolation and analysis.

6. Pharmaceutical Technology I & II

Pharmaceutical manufacture - department organization, process flow chart, good manufacturing practice, production planning & inventory control of perishables, receiving, shipping, storage & control systems, pharmaceutical production equipment for tablets, capsules, liquids, ointment, sterile products; materials assembly, prefinishing materials preparations (eg. granulation, dissolution, etc) finishing process (compression, filling, mixing, emulsifying etc.) dosage form inspection systems, packaging line layouts, procedures, label room operations, quality control (organization, analytical development lab, stability evaluation lab, stability protocol design, analytical control, biological control lab; quality assurance system)
Laboratory instructions include production techniques.

Year 3 Term 7 (Cont'd.)

7. Advanced Organic Chemistry III & IV (Fine Chemicals Option)

The theory part of this course emphasizes reaction mechanisms as applied to synthetic organic chemistry, design of sequence, new reagents, stereoselectivity & a study of natural products. The laboratory part of the course involves several projects in multistep synthesis of organic components and isolation of pure biochemicals from natural products.

8. Special Projects I, II & III (Fine Chemicals Option)

Each student selects a group of bio-, fine - or research-chemicals to study the feasibility of starting a small-scale manufacturing unit. The study involves both chemical/technical feasibility as well as business feasibility. For the technical aspect - student undertakes literature survey laboratory multistep synthesis, scale up studies as well as cost analysis; for the business aspect factors such as supply-demand research, government policies, marketing techniques and a complete business proposal preparation is undertaken. The project continues through subsequent terms but regular progress reports and final term report are required each term.

Year 3 Term 8 (Spring)

1. Chemical Economics

Applications of basic economic principles eg. capital investment, manufactured cost, cash position diagram, rate of return, etc. on plant operation; cost-estimation of a chemical plant (process flow sheet, equipment specification, estimates of purchase cost, "ready-to-run" cost, manufacturing and fixed costs); Risk, return rate & investment recovery; project analysis for new projects (existing plants, supply demand, future demands; time efficiency; optimum material balance; purchase & modification of existing plant vs. design & development; Rapid approx. methods (for chemical process equip.; non-process costs etc.)

2. Organizational Development:- How to Start-Finance and Manage

Contemporary entrepreneurship, entrepreneurial motivation, recruiting partners, conception & protection of a product - idea, business plan, mini-proposals; board of directors, management teams, market-survey, marketing strategy, research & development program, plant location & related considerations, money sources, venture capital, raising new money, managing & leading the entreprise, preparing for failure, sources of help for entrepreneurs - manufacturer's associations, periodicals, govt. agencies, institutions, etc.

3. Nuclear Chemistry

A study of nuclear stability & decay, chemical studies of nuclear phenomena, use of radioisotope tracers & synthesis of radio-labelled components. Laboratory study includes measuring of radioactivity handling & synthesis of radioactive compounds.

4. Drug Design - Principles & Practice

Considerations in selecting a potential candidate drug (eg. medical activity, physical & chemical properties for formulations, toxicity, pharmacology, stability, synthesis, patents), development of formulations, bioavailability of formulations, stability tests on formulations - process development, experimental studies in toxicity, blood level of drug; absorption, excretion and metabolism, carcinogenicity pharmacology & reproduction in animals, safety activity, technical & economic appraisal, clinical tests, packaging, data sheets, marketing and continions monitoring.

5. Pharmacology II

Please see Pharmacology I, Term 7

6. Pharmaceutical Chemistry II

Please see Pharmaceutical Chemistry I, Term 7.

7. Pharmaceutical Technology II

Please see Pharmaceutical Technology I, Term 7.

Year 3 Term 8 (Spring), Cont'd.

8. Advanced Organic Chemistry IV

Please see Adv. Org. Chem. III, Term 7.

9. Special Project II

Please see Special Project I, Term 7.

Year 4 Term 11

1. Industrial Microbiology

Study of certain processes whereby micro-organisms grown on a large scale are used to effect conversion of low cost substrates to commercially valuable substances. Fermentation; culture media; strain development, apparatus & equipment, sterilization, oxygen transfer - aeration & agitation, metabolic regulation, fermentation process kinetics mathematical models of fermentation, extraction of fermentation products, microbial proteins, products of material metabolism, antibiotics, alcoholic beverages.

2. Industrial Relations

Two aspects of industrial relations viz. (i) relationships between chemical industry & the political, social, & technological sectors of the environment and (ii) union-management relations, are examined from the perspective of the modern entrepreneur. The environment aspect explores & applies a variety of conceptual & analytical approaches to inter-organizational relations both in their historical & contemporary context. The union-management aspect examines collective bargaining relationships covering such topics as industrial relations systems, the functioning of trade unions, labour laws & canadian public policy in labour relations. Emphasis is placed on an examination of current issues in the labour sector including: how should society resolve the clash of consumer & producer interests; what is the ideal mixture of security & incentives in the labour sector; and can a modern economy simultaneously enjoy full employment, stable prices, and a minimum of government control.

Year 4 Term 11 (Cont'd.)

3. Marketing

An analysis of the market environment as related to chemical industry; marketing function, management strategy and performance; managing resources; information markets and the means of bridging the communication, utility, temporal and spatial gap separating company and consumer; marketing information systems, consumer and market behaviour, market promotion, marketing distribution.

4.3 ON-THE-JOB TRAINING

As stated earlier, an entrepreneurial education can achieve its goal only if the potential entrepreneurs get part of their training through "on-the-job" or "hands on" experience in the type of industry they wish to develop. The "on-the-job" training as an educational concept is not new and has been in use in various modes such as "apprenticeship training program", "internship training program", "cooperative education program", etc.

The "Cooperative Education program" is the most effective - both in terms of costs as well as of education - of all these programs. The effectiveness, cost-benefit analysis and the applicability of this program has already been studied by a Task Force on Cooperative Education at BCIT.*

The principal difficulty in using cooperative mode of education in entrepreneurial programs designed to generate a given industry in B.C. is the lack of such industry in the Province. In the absence of local industry, the students must travel to the regions where such training may be available and the Institution must make training arrangements in work-stations located far away from B.C. This may be both a difficult as well as somewhat expensive operation.

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* Please see: The Feasibility of Cooperative Education at BCIT., Task Force Report, March 1978

a. Work Experience for Fine Chemicals Option

The Fine or Research Chemicals manufacturing industries are practically non-existent in Canada. Fortunately, however, many 'industrial chemicals' manufacturers exist in B.C. as well as in the rest of the country. Some of these industries - particularly those with Research and Development departments and pilot plant facilities can be effectively used as cooperative education work sites for the students in the fine chemicals option.

b. Work Experience for Industrial Pharmacy Option

British Columbia Commercial Buyer's Guide lists a total of 15 companies in its 1979 edition, under the heading "Pharmaceutical Products - Wholesale and Manufacturers". Of these, only a few have any manufacturing facilities in B.C. - the rest of them being the marketing and distribution agencies and wholesale suppliers. It may be possible to use these local companies as work stations for business, distribution and marketing training but, it is obvious that training arrangements must be made with pharmaceutical manufacturers' in Eastern Canada and perhaps also in the United States.

Fortunately, the Pharmaceutical industries in Canada are keenly aware of the need for providing intensive working exposure to the industry with the objectives of fostering an awareness of

the industry amongst pharmacy students and stimulating interest in the industrial pharmacy as a career alternative. To achieve these objectives, the Pharmaceutical Manufacturer's Association of Canada (PMAC) has already initiated an "Industrial Pharmacy Studentship Program" which provides pharmacy students summer employments in manufacturing units. Under this program students receive both the salary as well as the relocation expenses. Hopefully, the PMAC would welcome efforts to initiate an educational program in Industrial Pharmacy and would provide guidance as well as access to work stations during the Cooperative Education work-terms.

A potential entrepreneur should not only be familiar but should have actual work experience in every aspect of the operation of his industry. The operations of a pharmaceutical industry can be classified into the following six categories:

1. Administration and Regulatory Affairs:

   Industrial organization chart; food and drug directorate liaison; working with FDD regulations pertaining to all aspects of the industry; enquiry handling, sales training, medical advertising, product surveillance and monitoring. General administrative practice, plant layout and overview of the industry.

2. Data Center:

   Department organization, function, significance, recording

systems and coordination of interdepartmental paper flow, computer applications data input, library and technical literature.

3. Sales and Marketing:

Sales organization, operational scope of marketing personnel, product promotion; sales training program, field sales unique to pharmaceutical industry e.g. detail schedule planning, accompany medical representative on physician and pharmacists/hospital calls, institutional display.

4. Production:

Production flowchart and layout, good manufacturing practice, technical services e.g. packaging engineering, industrial engineering, production planning, inventory control, receiving, shipping, storage, pharmaceutical manufacture including prefinishing and finishing process and dosage inspection as well as in-production quality control.

5. Quality Control:

Responsibilities of Q.C. Dept., analytical development, analytical control and microbiological control labs, quality assurrance systems.

6. Medical & Pharmaceutical R & D

Department administration, birth of a drug, pathological

and toxicological labs, pharmacology departments, animal study design, screening techniques, drug addiction and behaviour, small animal surgery, post-mortem lab procedures, tissue preparation and examination procedures, dosage form design and development, preformulation work and techniques, formulation development, stability testing, clinical supply manufacturing, pilot plant operation, product improvement research.

c. Schedule of Cooperative Work Experience in Industrial Pharmacy

The course of studies proposed in Section 4.2a recommends a total of 12½ months of on-the-job training as:

Term 3 - Summer (June, July, August)

Term 6 - Summer (June, July, August)

Term 9 - Summer (June, July, August)

Term 10 - Fall (Sept., Oct., Nov. to Dec. 15)

This period is divided into three sessions vs. Term 3 (3 mo.), Term 6 (3 mo.) and Terms 9 and 10 combined (6½ mo.)

The cooperative education students will be able to get adequate on-the-job training if the following schedule of operations and training is followed. The schedule also allows the student to get on-the-job training with more than one company if necessary, though not necessarily desirable.

Term 3 or 6 (3 mo.):	1. Administration & Regulatory Affairs.
	2. Data Center.
Term 6 or 3 (3 mo.):	3. Sales and Marketing.
Terms 9 and 10 (6½ mo.):	4. Production.
	5. Quality Control.
	6. Research and Development department.

Such a schedule complements the on-campus training.

It is expected that the objective of becoming an entrepreneur will provide strong motivations for the students to regard work-terms as excellent learning opportunities. Such a motivation coupled with direct, industry related, technological knowledge received in the classroom will enable these students to contribute significantly to their employer's objectives. These students will bring to their employment both the enthusiasm as well as the knowledge of latest developments in their field. Such a combination will provide above average returns to the training dollar put-up by the manufacturers in providing cooperative education employment.

4.4 FURTHER STUDY

A number of high-technology industries and products have been identified, in Chapter 3, as possible candidates for development through entrepreneurial education program. Once such an identi-

fication is confirmed through further study, it will be necessary to design an appropriate educational program to suit that particular industry. This can only be done by a joint effort and cooperation between the educators from the technology departments, industrial professionals in the field, and an educational planner who can also act as a coordinator.

The educational program in Fine Chemicals and Industrial Pharmacy technology, proposed here should therefore be viewed only in the light of the above comment. The details given here are to invite comments and suggestions for improvement from educators as well as from the industry.

Thus, further input and study is needed to refine the proposed programs in chemical/pharmaceutical as well as to develop programs in other fields.

4.5 SUMMARY AND CONCLUSIONS

1. An entrepreneurial education program for high-technology secondary industry must provide a blend of:
   i) basic scientific knowledge;
   ii) specific technological skills;
   iii) on-the-job experience (cooperative education);
   iv) business and management skills.

2. The graduates of such a program must receive guidance and assistance in the development of an enterprise. The institutions can provide such assistance through concepts such as research parks and industrial development organizations. A model for this is given in Chapter 5.

3. A four year, degree-granting, educational program that provides a blend of all the four factors stated above, is proposed.

4. A model 'Course of Studies', and 'Subject Outlines' for such a program in the field of Fine-Chemicals/Industrial Pharmacy is given. Pertinent guidelines for work experience through cooperative education in Industrial Pharmacy are also given.

5. Similar programs can be developed in other fields through the efforts of educationists, professionals and an educational planner/coordinator.

5. DEVELOPING MANUFACTURING INDUSTRY

5.1 THE NEED FOR POST-GRADUATION SUPPORT

In the experience of many educators, the real learning on the part of a student takes place after the student has graduated. This is generally true regardless of the quality or quantity of education given in an educational institution, or despite the institution's attempt to integrate diverse disciplines to produce a coherent curriculum.

The above statement does not imply that the process of learning does not occur at the educational institutions. On the contrary, educational institutions perform a very valuable and essential function of laying down the very foundations of learning for their students. The strength of such a foundation determines the quality of knowledge and achievements by the graduates in their later life.

The foundation, however, must not be mistaken for the building! While at the school, students generally tend to focus on the immediate achievements, measured in terms of their success in umpteen numbers of tests, quizzes and examinations. Their immediate goal is to demonstrate and prove to themselves, their

peers and to their teachers, that they can absorb and can run, what they call as, the rat-race. Their achievement of the long-range goals of skill and knowledge is merely incidental. For the students, who upon graduation are to receive weekly pay-cheques, who are to be hired hands in labour in someone else's garden, and for whom there is rarely to be any real victory or defeat, such a casuality of incidental learning may be acceptable.

The basic difference between the programs devoted to entrepreneurship and to those described above, lies in the post-graduation responsibility of the institution. A graduate of the entrepreneurial program has to blaze his own path and tend his own garden with dirt, dust, blood and sweat. His is to be the treacherous path of high-highs and low-lows. An educational institution offering an entrepreneurial education program cannot and must not, therefore, absolve itself of the responsibility of providing its venturesome graduates the much needed guidance and support in launching and operating their enterprises.

5.2 SUPPORT FROM THE GOVERNMENTS

The small-scale industries resulting from this type of proposed program will generate employment and produce wealth for the region, province, and for Canada. Consequently, the governments at all levels, municipal, provincial as well as federal have stakes in the success of such a program once it starts.

These governments, therefore, must share the responsibility with the educational institution, in providing guidance and support to the graduates.

In fact, economic assistance and other support from various levels of government to industries is not a new idea. Already, a number of municipalities have been offering land to attract industries. The Provincial Government offers aid through its Department of Economic Development, and through the organizations such as B.C. Development Corporation whose objective, like that of our proposed program, is to encourage industrial development in the Province. Various departments of the Federal Government, likewise, spend millions of dollars in aid programs for industry. Some of these programs are:

- Enterprise Development Program (EDP)
- Defence Industry Productivity Program (DIP)
- Regional Development Industrial Assistance Program (RDIA)
- Program for Export Market Development (PEMD)
- Cooperative Projects with Industry (COPI)
- Industrial Research Assistance Program (IRAP)
- Program for Industry/Laboratory Projects (PILP)
- Project Research Applicable to Industry (PRAI)
- Scientific and Technology Employment Program (STEP)
- Strategic Grants in Aid of Research (SGAR)

A complete list of financial assistance programs of the Provincial and Federal governments is given in Appendix 7.3.

Presumably, therefore, getting financial incentives for a worthwhile manufacturing project conceived by the graduates

of the entrepreneurial education program is possible, although not easy. In addition, a number of financial institutions including The Federal Business Development Bank provide financial support and in some cases even the venture capital to industries.

Though Canadian financial institutions are often accused of being too conservative and unresponsive when it comes to providing venture capital, in the words of a manager of a large Canadian bank, "in a free-enterprise society, there is always more venture capital chasing some viable and developed ideas than there are ideas chasing the capital". The key phrase in his remark is viable and developed ideas, and helping the Entrepreneurial Education graduates in articulating such ideas will be one of the important areas of post-graduation responsibilities of the educational institution.

Areas in which the institution can provide support to its entrepreneurial education graduates can be appreciated and evaluated through a development model described below. The model is based on an analysis of the problems normally associated with the development of a small-scale enterprise in the field of high-technology. To the extent that the analysis of the problems is valid, the ability of the model to resolve the problems can also be evaluated. Thus, in describing the model, we begin with an analysis of the problems.

5.3 MODEL FOR FINE CHEMICALS INDUSTRY

In the previous Chapter, an outline of the educational program for the development of fine-chemicals and pharmaceutical industries was given. Though the two industries are very much related, emphasis was placed on pharmaceutical industry while describing the on-the-job training aspect of entrepreneurial education. In this chapter, we now present a model for the development of fine-chemicals industry. Such a change of emphasis will widen the scope of this blueprint and will enable the planners to evolve more refined program for development of both the industries.

a. Nature of the Industry

A fine chemicals industry is an organization which manufactures organic and inorganic chemicals that are primarily used for research and analytical purposes. The fields in which these chemicals are used include chemistry, biology, biochemistry, medicine, pharmacy, agriculture, food-science and veterinary science. The demand for these chemicals is therefore, not only from the industrial laboratories in the above-mentioned fields but is also from hospital, educational and government laboratories. Thus, the range of demand for fine-chemicals is very wide.

Although the range of demand is wide, often the volume of demand for any given fine-chemical is very small. In fact, if the demand for a chemical is large it is usually classified in the "industrial chemical" category. The fine chemicals are thus characterized by their very low demand. Consequently, automated, high-volume processes are not suitable for the manufacture of these chemicals. They are produced in small batch quantities thus making the industry essentially labour intensive - the labour being highly skilled in the technology.

b. Assets and Liabilities

The small demand is both an asset as well as a liability for the development of fine-chemicals industry. On the asset side.

i) Being a small-scale industry, the capital requirements to launch a manufacturing unit are also small. (Provided that the quality control and marketing can be arranged separately. This aspect is discussed later.)

ii) Due to small investment, the size of risk is also small.

iii) Because of the high content of skilled labour, the unit cost of individual chemical is also very high. For example, whereas the industrial chemicals such as sulphuric acid or caustic soda sell for only a few cents

per kilo, the majority of fine chemicals cost hundreds of dollars, and in some cases even thousands of dollars per kilo*. Such high costs permits the manufacturers to compete in international markets without ever worrying about the labour or transportation costs deterrents.

iv) There are literally thousands of different fine-chemicals needed for research purposes by scientists around the world. Since their manufacture is based on high technological skill and because of the size of their demand, these chemicals often move freely across the national boundaries without any barriers such as tariff duties, foreign exchange restrictions, etc. Consequently, a fine-chemical industry located anywhere in the world can truly enjoy a free international market.

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* Prices of some fine-chemicals are given here to give the reader an idea of the prices in some extreme cases.

	Chemical	Price for marked unit	Price per kilo
1.	Dipyridine manganese dichloride	$20.00/10g	$2,000/kg
2.	Diphenylselenium	$15.00/ 5g	$3,000/kg
3.	N-(γ)-Acetylhistamine	$19.50/ 5g	$4,000/kg
4.	2,2'-Dithienyl	$36.00/ 5g	$7,200/kg
5.	5-Fluoro-6-methyl uracil	$120.00/ 5g	$24,000/kg
6.	N-Acetyl-hydroxy-L-proline	$121.00/ 5g	$24,200/kg
7.	N-Acetyl-5-hydroxytryptamine	$78.00/ 1g	$78,000/kg
8.	N-Acetyl Neuraminic acid from E. coli	$145.00/ 1g	$145,000/kg
9.	N-Acetyl Neuraminic acid from egg	$345.00/ 1g	$345,000/kg
10.	N-Acetyl Neuraminic acid synthetic	$165.00/ 1g	$165,000/kg

v) The number of fine chemicals that can be manufactured on a small-scale runs into thousands. Consequently, the development of a fine-chemical industry in British Columbia would permit the operation of hundreds of small-manufacturing units, each in fruitful cooperation, rather than unhealthy competition, with the other.

vi) Such a cooperative development would not only generate fruitful self-employment (and employment) for hundreds of skilled workers but would serve to attract more skilled workers to the Province, thereby generating newer skills and technology at an exponential rate.

vii) British Columbia is a vast province with uneven development; whereas certain regions of the province are fully developed in terms of industry and population, the major areas of the Province are uninhabited or dotted with small towns and villages with small population and no industry and employment potential. With proper planning, it is possible to stimulate growth in these small population centers through the development of fine-chemicals industry. No other industry could serve the objectives of regional economic expansion better.

On the liability side, the small-demand for fine chemicals creates a number of practical problems making it difficult for such an industry to develop.

Some of these problems are:

1. Due to low demands for individual chemicals, a fine-chemicals manufacturer will have to manufacture and market several different chemicals to be able to succeed. Starting a fine-chemicals manufacturing unit is like opening a hardware store. One must offer a large number of different products before one hopes to build up a regular clientele.

2. For a new graduate wanting to start-up a manufacturing unit, the larger the minimum number of chemicals that must be manufactured and marketed to achieve break even, the longer is the lead time. During this lead time the potential entrepreneur will need financial and other support while the feasibility studies on several chemicals are being completed.

3. In any business or industry, the build-up of regular clientele depends not only on the marketing effectiveness but also upon the trust and reputation enjoyed by the company and its products. In the fine-chemicals industry the process of winning trust and reputation, although critical, is very slow because the products are used mainly for research and analytical purposes. Research and analytical chemists will not turn to a new company or supplier unless they feel assured of the absolute purity and ready availability of a large number of different chemicals they need in small

quantities. In fact these two factors, viz. purity and ready availability, are so important to the research chemists that they will not risk their research efforts by buying chemical from new companies even if the new companies decided to give away their products. This makes marketing efforts very difficult.

4. In fine-chemicals industry, though the capital required to set up production facilities is usually small, the overall costs and risks involved are high because of the following.

   i) long and costly lead time required for feasibility studies and business plan articulation.

   ii) costly marketing effort due to a wide range of products, customers and territory.

   iii) slow pace of establishing trust and reputation.

   iv) high cost of carrying skilled labour.

   v) high cost of instruments needed for a vigorous quality assurance program.

5. If a small company were to depend entirely on its own manufactured chemicals, it is likely to face a negative cash-flow situation for a long time because of the above

factors. Such a situation discourages not only the potential entrepreneur but also the venture capital.

Unless a solution is found to the above mentioned problems, it is highly unlikely that a graduate of the entrepreneurial education program, with the best of motivation and managerial technological skills, will venture in such an enterprise.

c. Designing the Model

To be realistic and effective, any model designed to develop a fine-chemicals industry in the province must resolve all the above-stated problems in addition to the problem of availability of skilled human resource. The educational program suggested earlier attends to the problem of skill, whereas the model that follows attempts to address the rest.

The model proposed here (Fig. 5-1) is based essentially on the concept of Cooperative association of small-scale manufacturers. The basic concept has worked in Canada in such areas as agricultural products, and there is no reason to believe that an application of the basic principle to the field of high-technology, manufacturing industry is impossible. Given below are the recommendations for such an application:

1. The model proposes the setting up of an industrial park devoted exclusively to fine-chemicals, pharmaceuticals

and other small-scale, high-technology industries conceived through the entrepreneurial education program. The term "Discovery Park" has already been coined for such an entity by the Hon. Dr. Patrick McGeer - the Minister for Education, Science and Technology of the Province of British Columbia.

2. The Discovery parks should be set up in the vicinity of the institution offering entrepreneurial education program. In the case of BCIT, the area immediately west of Willingdon Avenue appears suitable for this purpose.

3. The Ministry of Economic Development should, through organizations such as British Columbia Development Corporation (B.C.D.C.), undertake to develop basic facilities in the 'Discovery Park'. For the Fine-Chemicals industries section of the park, these facilities would include several small buildings (approx. 2500 sq. ft. each) which will serve as production, research and office facilities for each of the small manufacturing companies (SMC). The buildings should be adequately serviced to function as laboratories as well as production units. B.C.D.C. should own these buildings but will lease them to the graduates of the entrepreneurial education program to set up SMCs.

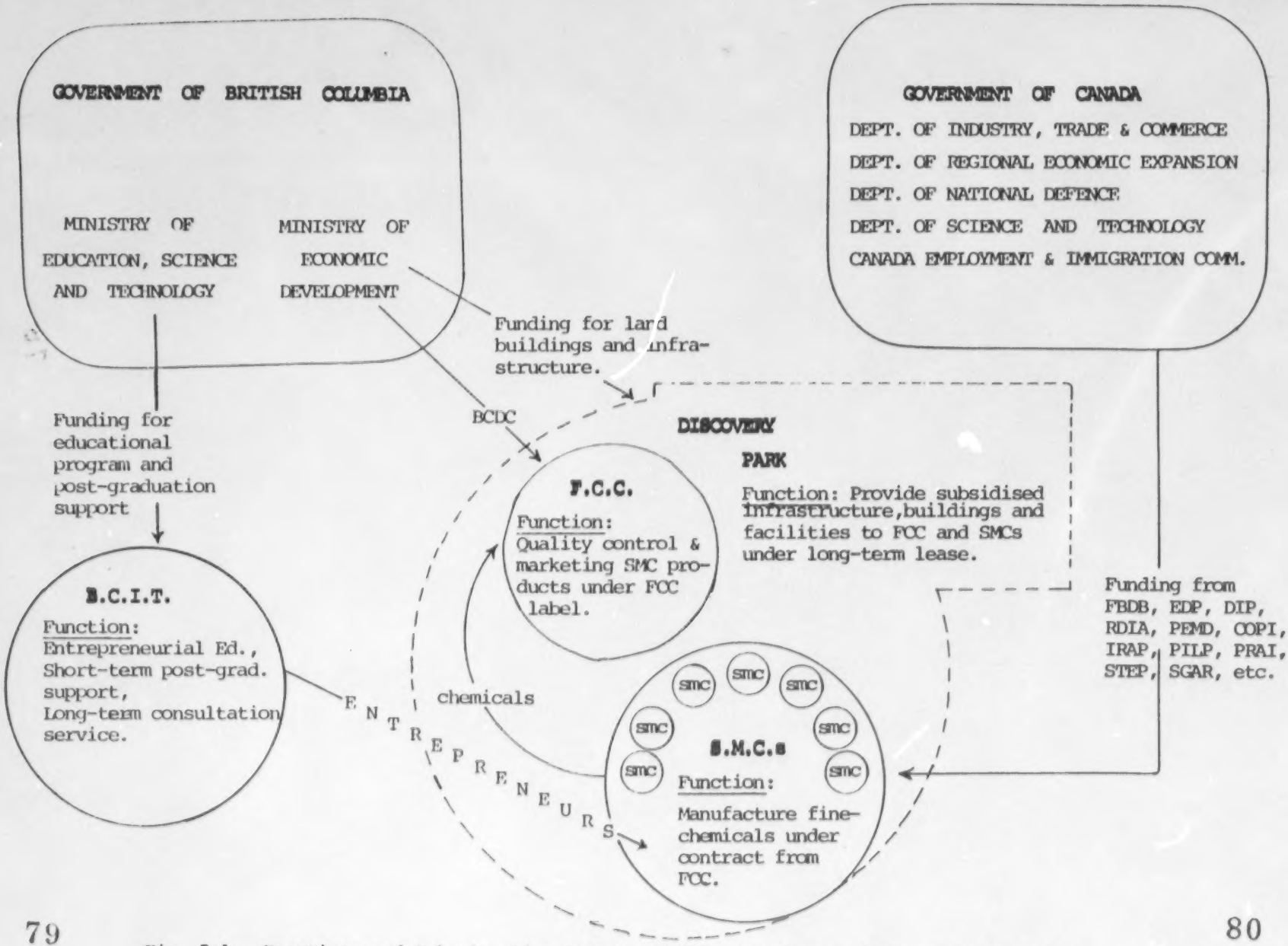
GOVERNMENT OF BRITISH COLUMBIA
MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY
MINISTRY OF ECONOMIC DEVELOPMENT
GOVERNMENT OF CANADA
DEPT. OF INDUSTRY, TRADE & COMMERCE
DEPT. OF REGIONAL ECONOMIC EXPANSION
DEPT. OF NATIONAL DEFENCE
DEPT. OF SCIENCE AND TECHNOLOGY
CANADA EMPLOYMENT & IMMIGRATION COMM.
Funding for land buildings and infrastructure.
BCDC
Funding for educational program and post-graduation support
DISCOVERY PARK
Function: Provide subsidised infrastructure, buildings and facilities to FCC and SMCs under long-term lease.
F.C.C.
Function:
Quality control & marketing SMC products under FCC label.
B.C.I.T.
Function:
Entrepreneurial Ed., Short-term post-grad. support, Long-term consultation service.
ENTREPRENEURS
chemicals
S.M.C.s
smc
Function:
Manufacture fine-chemicals under contract from FCC.
Funding from FBDB, EDP, DIP, RDIA, PEMD, COPI, IRAP, PILP, PRAI, STEP, SGAR, etc.

Fig. 5-1: Functions and Relationships Between Different Units of the Proposed Model

4. Provincial and Federal Governments should take steps enabling B.C.D.C. as well as Federal Business Development Bank (FBDB) to provide venture capital to 'Discovery Park' industries on a priority basis.

5. The SMCs, though owned and operated independently by individual entrepreneurs, will in effect be the independent manufacturing arms of a single, larger, Fine-Chemicals Corporation (FCC).

6. The FCC will serve as a research, quality control and marketing organization for all the SMCs and will market all products under its own label. Like any other corporation, FCC too will operate on the basis of profit motive.

7. The initial funding for FCC will come as a share capital from the provincial government who will subscribe to the shares through organizations such as British Columbia Resources Investment Corporation (BCPIC). However, these shares, with a fixed value for the first 5 - 7 years, will be transferred to SMCs as a part payment for the chemicals they supply to FCC.

The net effect of such a financial arrangement is the ultimate and total transfer of FCC ownership to SMCs. Through

such an arrangement, the Provincial Government provides, in effect, an interest-free loan to set up a brand new industry in the Province, without long-term permanent, civil-service involvement in the industry.

5.4 SUPPORT FROM THE INSTITUTION

The role of the educational institution such as BCIT is to provide short and long-term post-graduation support to its graduates. The long-term support will be in the form of consultation services for the growth and development of SMCs already established in the park. This service could be in business as well as technological areas, offered by BCIT faculty on a fee basis.

The short-term post graduation support, however, is for those graduates of the entrepeneurial program, who are unable to launch an enterprise immediately upon their graduation.

According to the educational program described in Chapter 4, students in fine-chemicals option begin their 'feasibility studies' special projects in organic synthesis in Term 7 and continue through Terms 8 and 11. During these periods, students get an estimated total of 550 hours for project work. This is approximately equal to about a ½ year's work on a full-time basis. During this time, students are also taking other courses

and are unable to devote much attention to their projects. Some students may be able to continue their projects throughout their cooperative work-terms 9 and 10. However, in most of the cases, continuation of project work may be neither possible nor desirable.

Thus, except in few cases, most graduates will have completed feasibility studies on very few, if any, chemicals. For the majority, the special projects would serve simply as a training in research methodology in chemistry as well as in entrepreneurship. Such students will need post-graduation guidance and assistance in conducting further feasibility studies so that they may be able to identify the group of chemicals which they could produce upon launching their own SMC.

During this period, they will also need considerable guidance and encouragement in articulating their goals and objectives so that a formal business plan and a mini-proposal, acceptable to venture capitalists, discovery park organizers and FCC directors, could be prepared. Preparing a business plan and proposal requires considerable skill, time, study and patience. Potential investors often need precise information about not only the skill, vision and synergy of the founding team, but also about the organization chart, start up plan, growth potential, description of initial products, rate of growth, anticipated percentage of market

capture, pro-forma financial statements, projected staff and plant requirements, equity and debt structure, etc. Such comprehensive documents often require several months and coordination of technical, financial, accounting and legal assistance to compile and write.

The combination of feasibility studies and business plan articulation may require a period of up to two years. This period between graduation and actual start-up of a SMC should be the time for the educational institution to provide support and encouragement to the graduates.

5.5 RESEARCH POTENTIAL AT THE INSTITUTION

One approach to providing such a support is for BCIT to look beyond its proposed polytechnic goal. By the time the polytechnic concept becomes a reality, the quality and concerns of the then faculty would have changed to warrant the facilities for faculty research. The research direction of the polytechnic should concentrate, as does its primary teaching role, on applied problems of social and economic relevance.

In the context of the needs of British Columbia, particular attention should be paid to the integrated approach of the development of economically exploitable high technology. An educational institution which provides entrepreneurial

education program for the development of a manufacturing complex in nearby discovery park, will naturally be the institution philosophically poised to undertake such a research. In fact, it could be the only institution in the Province which may be concerned as well as capable of undertaking an integrated research in industrially applicable problems.

To be able to reach such a research potential in the applied field, the institution should develop an intermediate step where graduates of the entrepreneurial education program are allowed to continue their feasibility studies for a year or two at the institution under a matrix approach to research. The matrix approach, which is increasingly being used in science-based industries, tackles an interdisciplinary research by appointing a project manager who could call upon the skills available from the other staff, but would not monopolise the whole of their time in just the one project.

Thus, for a year or two, like a post-graduate student at a university, the entrepreneurial education graduate will continue his feasibility studies and business plan articulation at the institution under the direction of a research manager. It is expected that during this period each graduate will have completed feasibility studies on a line of products involving 10 to 15 chemicals. Like post-graduate students at the university, these students should also receive maintenance allowance, and the

institution should get research grants from the Ministry of Education, Science and Technology. This time, however, there should be no formal courses to attend, no examinations to write and no degrees to be awarded. Culmination of the project into a viable SMC will be both a motivation as well as an award for the student.

5.6 BENEFITS OF THE PROPOSED MODEL

1. Each graduate will be able to establish a private small enterprise (SMC) which will manufacture a selected number of chemicals under contract from FCC, which is a larger, quality-control and marketing corporation.

2. Each SMC will be owned and operated by an expert chemist who has also an understanding of the business world.

3. The potential entrepreneur will not be faced with high and discouraging costs involved in feasibility studies and business plan development. Rather than struggling on their own through a l ng gestation period on a hit-or-miss basis, these functions are carried out efficiently and economically under the direction of experts at the institution.

4. Since each SMC is initially working under contract from FCC, the sale of its products at a mutually agreed price

is assured. The pricing structure will ensure that the SMC, with its low overheads, will be able to survive by producing enough quantity and number of chemicals for FCC.

5. Since as many as 10 to 15 trained entrepreneurs will be produced by the institution each year, it is hoped that 5 to 8 new SMCs will be formed annually during the initial growth period. Presuming that each SMC will, on an average, undertake the production of 10 new chemicals, the list of market offerings by FCC would exponentially grow to several thousand chemicals in a very short period. This will be further increased by the fact that each SMC, after an initial rooting period of one or two years, will be tempted to undertake its own research to produce more chemicals along its established line of products. FCC and the institution will continue to offer consultative services if needed.

6. The quality control function (final purification, if needed) and the complex marketing function are being carried out centrally by FCC under FCC's own label. Such an arrangement solves, for the SMCs, crucial problems of:

   i) high cost of quality control,

   ii) establishing reputation directly with the customers over a wide territory,

   iii) high marketing costs, etc.

The central operation will be relatively much more economical and efficient thus enabling FCC to compete favourably with other companies and foreign imports.

7. Although the actual manufacturing is carried out by a large number of SMCs, as far as the outside world of research scientists and other customers is concerned, it is dealing with only one company, viz. FCC. Such an arrangement will make it easier for the SMC products to gain respectability and trust in the market.

8. The ultimate and rapid transfer of FCC shares and control in the hands of SMCs will ensure effective and efficient operation of the companies at both levels.

5.7 FURTHER STUDY

The proposed model is a novel concept involving formalized cooperation between an educational institution, several small companies started by the graduates of the institution and a large marketing corporation operating on a cooperative basis. Furthermore, the concept depends upon the initial funds provided not only by the different levels of government, but also by different ministries and departments of the governments. Certainly, such an arrangement appears very complex and must involve several economic, political and legal implications.

Nevertheless, the concept and the model is described here in enough details so that the complexities and implications can be further studied, and the model further refined. At this time our only excuse for this presentation is that unless a concept is articulated and presented to those whose involvement will be required, it will never get a chance of critical evaluation, further refinement and possible realization.

We believe that the basic concept is sound, and given vision, determination and further refinement, it can work. If it does, not only will it make further advances in cooperative mode of education, but it will also usher in new economic and technological impetus in the Province. Also, because similar problems exist in other Canadian provinces, the results of this study can have a tremendous impact on the Nation as a whole. In this connection, the recent move of the Government of British Columbia, to include Science and Technology along with Education to create a single Ministry of Education, Science and Technology, is certainly a visionary and hopeful development.

5.8 SUMMARY AND CONCLUSIONS

1. The basic difference between the entrepreneurial education (E.E.) graduates and other graduates is that the E.E. graduates are expected to launch their enterprises almost immediately upon graduation. This independent trail

blazing must be supported by the institution as well as by the government.

2. The institutional support is recommended to be in the form of providing facilities and guidance to the graduates in completing feasibility studies and business plans. The kind of support proposed is similar to that given the post-graduate students in a university.

3. The support from the government is to be in the form of financial grants (similar to research grants in a university) to the institution, creation of discovery parks, and incentives in the form of venture capital.

4. A fine-chemicals manufacturing unit is taken as an example to illustrate a typical high-technology industry. Problems normally encountered by an entrepreneur in starting such a unit are identified. Similar problems exist in other high-technology industries.

5. A model involving the 'discovery park' concept - working through active cooperation between educational institution, different departments and levels of the Government, small-scale manufacturing units, and a cooperative-based marketing corporation - is proposed.

6. Benefits to be accrued from such a model, and its ability to solve the problems facing an entrepreneur are discussed.

7. It is recognized that the proposed model may appear too complex to materialise, and may involved several economic, political and legal complications. However, it is felt that these problems are not insurmountable given determination and flexibility.

6. COST CONSIDERATIONS

The educational program as well as the industrial structure proposed in this study is constructed to stimulate a critical examination and refinement of the proposed model. If the central concept of the blueprint gains acceptance from BCIT and from the Ministry of Education, Science and Technology, a further study will be necessary to evolve educational programs as well as industry development models for a number of other high-technology industries.

The educational program and the model suggested here for Fine-Chemicals/Pharmaceutical industries will also undergo some changes as a result of further consultations. Consequently, it is neither possible nor advisable at this stage, to expend time and energy in an attempt to determine exact costs involved in various aspects of the proposal.

Nevertheless, if the proposal is to gain acceptance, even if only in principle, it must be examined broadly in terms of financial requirements and returns. What follows is a broad examination of the nature of costs involved in developing various units of the proposed structure and a justification for these costs in terms of tangible and non-tangible returns. Such an examination will permit critical evaluation of each unit

and will encourage comparison with other possible alternatives. Refinement of the proposed structure can be achieved only through such comparisons.

6.1 COSTS FOR THE EDUCATIONAL PROGRAM

The costs for the educational component of the proposed structure will, of course, depend upon whether BCIT or some other institution is selected for implementing the program. Being technological in its outlook, BCIT would naturally be the institution of choice for the proposed program. A large number of courses of the type and nature required for basic technological knowledge and entrepreneurial education, are also already being offered at BCIT.

However, the proposed structure requires atleast four years of formal on-campus instructions and possibly two more years of post-graduation facilities. Unless the Ministry enables BCIT to become a polytechnic or a technological university, the proposed program may not be possible at BCIT. In that case, alternatives such as developing the program at UBC (Faculty of Pharmacy or Applied Science), or at SFU (Faculty of Science) should be examined. Such alternatives may prove costlier and may not permit rapid development of entrepreneurial education programs in other manufacturing areas. Establishing a new institution devoted to small business and entrepreneurship has also been sugested*.

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*"Entrepreneurial Education And A Small-Business Institute - A Report For Vancouver Kiwanis Club And Vancouver Community College", by D. M. Brousson, Oct. 1977.

Assuming, however, that BCIT becomes the British Columbia University of Technology (BCUT), a new 'Division of Entrepreneurship' should be created within the new university by joint funding from the Ministry of Education, Science and Technology, and the Ministry of Economic Development. This new Division would evolve and offer Entrepreneurial Education (E.E.) programs patterned after the model proposed in this study. We may now proceed to examine the various cost elements in the proposed model.

a. Training During First Two Years

The course of studies proposed for first two years (page 38) is essentially the same as that being presently offered to the Chemical and Metallurgical Technology students at BCIT. The few modifications and alternate courses suggested involve minimal costs because of the fact that the proposed alternates are already being offered to students in other programs at BCIT. Only 3 of the courses proposed for first two years of the program are new to BCIT. These are:

1. Organic Synthesis I & II - A full-year course in theory and practicals for Fine Chemical Options (6 hrs. per week)

2. Pharmaceutics I & II - A full-year course in theory and practicals for Industrial Pharmacy Option. (6 hrs. per week)

3. Pharmaceutical Law, Ethics & Organization - A one-term course (½ course) in theory for Industrial Pharmacy Option. (3 hrs. per week)

These new courses are equivalent to the teaching load of one additional faculty member. The additional facilities, equipment, laboratory space etc. needed for these courses would be minimal because of the small number of students in these options. In fact, such facilities may already be available in the existing programs. The services of a cooperative education coordinator may be needed to arrange and supervise the work-terms No. 3, 6, 9, and 10.

b. Training During Third and Fourth Years

The courses proposed for this post-diploma level of education are all (except No. 16.344 - Managerial Accounting) new to BCIT. Some of these courses - e.g. Production and Materials Control; Industrial Relations; and Marketing - may be offered by modifying some existing courses at BCIT. A few other courses viz. Biochemistry; Pharmacology; Pharmaceutical Chemistry; Drug Design; Nuclear Chemistry; and Advanced Organic Chemistry are currently available either at SFU or at UBC. But the remaining courses viz. Pilot Plant Design; Pharmaceutical Technology; Chemical Economics; Organizational Development; and Industrial Microbiology, are designed specifically for the proposed program.

The financial outlay required for offering these post-diploma courses must be examined in the light of the proposal to change the status of BCIT to BCUT. If such a change is granted, a number of the proposed courses would be useful to students in other programs. Offering all the above courses on-campus at BCIT would then be economical and advisable. The overall costs would then be comparable to those incurred for the 3rd and 4th year programs in applied science faculties in UBC.

If a parallel development in all other areas of BCIT does not appear feasible, consideration should be given to the possibility of starting entrepreneurial education programs to develop other high-technology industries. In the interim, however, the possibility of closer cooperation with SFU and UBC should be considered. Such cooperation would enable entrepreneurial education students from BCIT to take some of their post-diploma courses at SFU or UBC. Only those courses which are not available at these universities would then be developed at BCIT.

Such an arrangement is practical and could significantly reduce the costs of offering 3rd and 4th year programs at BCIT. In view of the small enrolment expected in BCIT's entrepreneurial education program (approximately 10 to 15 students for fine-chemicals and Industrial Pharmacy options), and the decreasing enrolments ir the universities, such cooperation may be mutually beneficial.

On the long-term basis, however, such an arrangement appears to be undesirable and perhaps harmful to BCIT as well as to the very goals of entrepreneurial education. If BCIT is to be charged with the responsibility of developing a fine-chemicals and pharmaceutical industry in the Province, then it follows that such expertise and technological capability to execute the responsibility must exist within the Institute. An arrangement whereby BCIT students take pharmaceutical courses at UBC and advanced organic chemistry at SFU might not permit the development of such expertise at BCIT. The goals of entrepreneurial education may thus suffer.

c. Post-Graduation Support

Earlier, this phase of the Entrepreneurial Education (E.E.) program was compared with the post-graduate studies in universities. Unlike post-graduate students, the E.E. graduates will not be required to take any formal courses and examinations. Nevertheless, the amount of experimental work required of each graduate, and the demands of faculty time in directing such work could easily be comparable to that found in a typical post-graduate program. The level of funding for faculty, institutional facilities and student assistance to E.E. graduates should therefore be at a level comparable to that available to a post-graduate program in applied sciences in any Canadian university. It is hoped that a portion of these funds would come from Federal agencies.

6.5 COSTS FOR THE INDUSTRIAL MODEL

The proposed industrial model consists of three major units viz. Discovery Park, Small Manufacturing Companies (SMCs), and a Fine Chemical Corporation (FCC). The ultimate goal of the exercise is to generate enterprise, industry and wealth and employment in the Province. Consequently, the total costs involved in promoting such a model must be examined in terms of the expected net returns on the investment and other benefits to be accrued to the ordinary taxpayer in British Columbia and in Canada.

a. The Discovery Park

The concept of a discovery park is not much different from that of a shopping mall. Both are built at enormous initial costs, both are built to provide facilities and infrastructures to businesses, both promote economic activities, and on a long-term basis both should provide net returns to the investors. The basic difference between the two, however, is in the nature of activities carried out at these locations. Whereas the main activity in a shopping mall is trading and commerce, that in a discovery park is manufacturing. Thus, whereas shopping malls promote tertiary and service industries, a discovery park is a place where secondary manufacturing industry is promoted.

A discovery park is essentially a light industrial park. The two differ in that the discovery park industries are high-technology, and therefore, research and development oriented industries, while the industries located in a light industrial park may not necessarily be research oriented.

The discovery park industries are productive enterprises generating new technology, productive employment and national wealth. This fact changes the initial investment picture. Whereas, the shopping malls are normally financed and built by private developers, the responsibility for building industrial parks is traditionally picked by the governments. Similarly, whereas the rent collected from the businesses is the reward for a private developer, the national wealth generated through production, the employment created, the various taxes generated through increased industrial activity, and the technical advances made by the country may be looked upon as financial and non-tangible rewards for the government and the nation.

Consequently, it is expected that the funds for the development of the discovery park will come from the Ministry of Economic Development of the Government of British Columbia. It could be a project of the British Columbia Development Corporation (BCDC) and may be regarded as a form of subsidy normally made available to the businesses under such programs as: Assistance to Small Enterprise Programme (ASEP), and Technical Assistance Programme (TAP).

b. Small Manufacturing Companies (SMCs)

As envisaged now, a discovery park for the fine-chemicals and pharmaceutical industries should be developed on land large enough to hold as many as 50 or 60 small manufacturing industries and a larger quality control/marketing corporation (FCC).

Each unit for the SMC would need built up area of approximately 2500 sq. ft. floor space with provision for future vertical expansion to provide more area. Each built up unit will have space for production area (ca 1200 sq. ft.), research and development area (600 sq. ft.), storage area (ca 400 sq. ft.), and office/library area (ca 300 sq. ft.). Consideration should also be given to the possibility of equipping these areas with appropriate facilities such as central supply of metered power, gas, hot-cold-distilled water, vacuum line, and even built-in laboratory work-benches, storage racks, etc. The whole idea is to provide the facilities so equipped that the entrepreneur can just walk in and start manufacturing activity without spending time in facilities planning, etc. The size of the venture capital needed by each entrepreneur will also be considerably reduced thereby.

Initially, only about 8 to 10 such units will be needed to accomodate first batch of E.E. graduates. (Even if the E.E. program starts in 1980, the first batch of SMCs generated by

the program will not be operational before 1985). Addition of about 8 to 10 more units each year for next 5 to 6 years should, however, be planned and provided for.

If physical facilities for SMCs are provided as suggested, the financial assistance to launch an enterprise will be only that small amount needed to purchase glassware, equipment, small reactors, furniture, etc. It is desirable that the entrepreneur raise part of this as a venture capital from private sources such as relatives, partnership arrangements, and financial institutions. Approximately 50 to 60 percent of the required capital should then be made available to the SMC from BCDC, FBDB, etc. as low interest loan. The Government of British Columbia presently makes such loans available to small businesses through schemes such as Low Interest Loans Assistance Programme (LILA).

c. Fine Chemicals Corporation (FCC)

This proposed corporation is a somewhat novel and complex concept and the readers may find it difficult to grasp. The complexity lies in the fact that although the original funding for FCC is to be almost exclusively from loans and the equity shares purchased by the B.C. Government (through vehicles such as BCDC, and BCRIC), the ultimate ownership of FCC is to be transferred, according to a predetermined plan, to the participating SMCs.

Furthermore, though the Government would be responsible for initial investment in the FCC, according to the present proposal, it would not necessarily enjoy the total control over the FCC. The FCC would be governed by a Board of Directors, and for a fixed period of first five years after SMCs become operational the Chairman of the Board would be an appointee of the B.C. Government. A majority of the members of this Board would be from amongst the entrepreneurs who own the SMCs, with BCIT having some representation on the Board.

The transfer of equity shares from the Government to the SMCs would take place in the form of part-payment by FCC for the chemicals manufactured by the SMCs. It is expected that the total transfer of shares could require between 5 to 10 years and that the FCC would then become a truly private marketing enterprise operated on a cooperative basis by the SMCs. A provision limiting the percentage of total shares owned by any single SMC should also be considered.

In terms of facilities, the FCC would require office space, a large warehouse, and facilities essential for quality control and marketing. The quality control facilities include not only the analytical instruments, but also the equipment needed for such operations as bulk-crystallization, distillation, vacuum sublimation, chromatography, etc. to achieve the desired purity.

Again, the idea is that the SMCs should achieve the purity they could with their relatively inexpensive equipment, but the final, absolute purity would be the responsibility of FCC which would be the only one equipped with the expensive equipment.

The built-up area for FCC may be initially small, but in view of the possibility of its exponential expansion with the increasing number of SMCs each year, ample land must be initially available. It is also possible that FCC may, at an early stage, undertake such activities as:

1. purchasing technical grade chemicals from outside suppliers and marketing them under FCC labels after purification.
2. purchasing chemicals from outside sources at bulk rate and supplying them to SMCs at preferred prices. This may amount to considerable savings for SMCs in such items as organic solvents.
3. seek custom synthesis contracts from government and industrial laboratories, develop the processes and sell the manufacturing rights to one of the SMCs.
4. conduct feasibility studies on new lines of chemicals so that such studies may then be exploited by the FCC itself or may be sold to the SMCs.

Briefly then, the FCC envisioned here will be like any other business corporation - operating with vision and innovation as a profit making entity.

6.3 SUMMARY AND CONCLUSIONS

1. Developing skilled work-force for high-technology industries requires an institute which can provide at least four years of formal, on-campus, technological instructions and possibly two more years of post-graduation facilities.

2. At BCIT, facilities and courses required for first two years of the proposed program are already available and no additional costs for these two years are deemed necessary, except for the services of a cooperative education coordinator.

3. Of the courses proposed for third and fourth year, BCIT could offer some by modifying a few of the existing courses. Remaining courses may either be developed, all at BCIT, or an agreement may be reached with SFU/UBC whereby E.E. students take some of the existing courses at these universities and only few are then developed at BCIT. The later alternative may be more economical but not necessarily desirable.

4. Costs for the post-graduation support to E.E. graduates are comparable to those for the post-graduate programs in applied sciences in Canadian universities.

5. The Ministry of Economic Development of B.C. should develop a discovery park on the East side of Willingdon Avenue, across from BCIT. The park should initially have facilities for 8 to 10 Small Manufacturing Companies (SMCs), each with

about 2500 sq. ft. of floor space, and a larger Fine Chemical Corporation (FCC). However, it must be planned large enough to accomodate up to 60 SMCs.

6. If properly developed discovery park facilities are rented to E.E. graduates, only a small amount of capital would be needed by each entrepreneur to launch a SMC. The entrepreneur should raise up to 50% of this and BDCD, FBDB, etc. should make the rest available as venture-capital, low-interest loan.

7. BCDC or BDRIC should initially purchase all the shares in FCC and should also have initial representation on the FCC Board. However, all the shares and control of FCC would be gradually transferred to SMCs over a planned period of 5 to 10 years. Thereafter, the FCC would be jointly owned by SMCs and operated as a cooperative business venture.

8. Other profit-generating activities for FCC are proposed.

7. APPENDICES

June 29, 1977

7.1 INITIAL BASIC PROPOSAL

BASIC CONCEPT

The educational philosophy, often implicit in university degree programs is that, "the historian, philosopher, biologist, chemist, or student of English is not necessarily going to take a job in these subjects. He will be educated in the sense of knowing how to master a subject, and his education will be adapted to the wide range of occupations." On the other hand, the role assigned to vocational schools and technical institutes in Canada is to train people to perform specific technical jobs in their chosen fields. While both these types of institutions have played roles admirably well, a third kind of institution needs to be evolved in Canada - indeed in British Columbia. Such institution will, no doubt, seek to attract and cater for those with vocational interests but will give them degree level education enabling their graduates to contribute to a wide range of occupations in a given industrial field.

THE POLYTECHNIC CONCEPT

B.C.I.T. has established for itself an excellent reputation as a two year institute granting certificates or diplomas in technical fields. These diplomates are readily accepted by industries and institutions as skilled technicians but their role in such industries is limited because of their limited training as diploma holders. A number of diplomates from technical institutes in the country desire to convert their diploma to a degree through several courses which will give them wider adaptability. For many, such conversion has proven elusive or cumbersome.

Science graduates from universities often find themselves unprepared

for industrial positions. Our industries are becoming increasingly alert to a need to engineer their own induction and training programs to make the best use of graduate entrants. These graduates certainly fail to appreciate economic, management and business acpects of an industry and are therefore confined to a limited role as plant operators and laboratory workers.

Industrial need for managerial and executive positions in Canada is presently met with by people with commerce, economics or MBA degrees. These graduates, though competent in business aspects, spend years on the job before they gain real understanding of the technical details and sophistication of the industry they work for. Meanwhile, a prime requirement of our industries is for a person educated so that he is capable of mastering a field, is adaptable to a wide range of duties and is fit to enter the industry with understanding and appreciation of its varied facets. Educating such a person must involve industries as massively as it involves an institution providing the formal classroom education. Educational program for such a person must provide a blend of scientific/technical and commercial/administrative training together with field/industrial experience. The explicit goal of such education should be, "to produce graduates capable of accepting junior executive positions in the specific industries and fields of their choice." Institutions providing such an education may be looked upon as polytechnics or technical universities.

Polytechnic graduates will have basic understanding in such varied fields as, business organizations, economics, accounting and marketing, company and labour laws, social and environmental responsibilities advertising and consumer behaviour, human management and financial control, etc. along with in-depth knowledge of science, technology

and manufacturing practices in their specific field. Such an approach does not necessarily mean that the goal will be achieved by training a student for a technical diploma for two years and then tagging on a mini-MBA program on him. On the contrary, such a disjointed approach might create a serious problem of mistaken identity on the part of the student and may limit his usefulness to the industry. A proper blend of subjects spread over all the four years of a student's degree program will provide flexibility and will produce graduates of greatest interest to industries. (For example, a tentative program for a degree in food management is outlined in Appendix 'A'. The program is aimed at food manufacturing/processing as well as institutional and hotel/restaurant catering industry.) In the subject of industrial chemistry alone, as many as 20 such programs can be designed in fields ranging from petroleum, plastics..... to fine chemicals and pharmaceutical industries.

THE PROPOSAL

1. In view of its established leadership in technical education in the Province, the B.C.I.T. consider the possibility of a polytechnic (or technical university) role for itself in the near future.
2. Such a role may be attained without abondoning its present responsibility of providing diploma level technical/vocational programs.
3. Since 'Polytechnic' programs will be designed primarily to meet the need for managerial/executive level personnel in industries, the Institute will be able to cement further its relationship and partnership with industries by involving them in the planning stage of the 'Polytechnic' programs.

A SAMPLE PROGRAM FOR POLYTECHNIC DEGREE

Bachelor of Technology (B.Tech.) in

Food Management

NOTE: A tentative program of this nature will be presented in various fields as working papers for considerations and comments from faculty and industry. Flexibility in the program is introduced at the third and fourth year levels. The variety of career opportunities in food industry means that emphasis in the program can differ according to student interest and yet each would have a valuable part to play in the total pattern of education for food industry. At the same time, there is enough of stern vocational reality in the program to make the student aware of the hard demands the industry can place upon a manager.

i. Course numbers are arbitrarily chosen and do not refer to existing courses.

ii. Numbers in paranthesis represent hours per week for lectures and laboratory sessions respectively.

iii Admission will be restricted to 15 or less students per year in each program.

First Year (Foundation year for many programs)

First Term			Second Term		
Engl 101	English composition & creative writing	(3.0)	Engl 102	English - business writing and reporting	(3,0)
Math 101	Business math.	(3 0)	Math 102	Elem. statistics	(3 0)
BIOL 101	Elem. Biology	(3.2)	Biol 102	Human physiology	(3 2)
Chem 101	General chemistry	(3.2)	Chem 102	Structure & reactions	(3.2)
Cate 101	Catering skills	(3 2)	Cate 102	Catering studies	(3 2)
Econ 101	Elem. Economics	(3 0)	Econ 102	Microeconomics	(3 0)
	Total	(18.6)		Total	(19.6)

At the end of first year student will be placed as a trainee in a recognized hotel for 3 summer months. Honorary examiners from the industry will be appointed to assess student performance.

Second Year

First Term			Second Term		
Phys 201	Elem Physics	(3,2)	Chem 203	Instrumentation	(3,2)
Food 201	Intro. to food Sc.	(3.2)	Food 202	Nutrition I	(3.2)
Law 201	Fundamental legal concepts	(3 0)	Law 202	Legal theory & legal processes	(3 0)
Psyc 201	Intro. to Psychology	(3,0)	Psyc 202	Consumer behaviour & work organization in food industry	(3 0)
Acco 201	Accounting & financial communications	(3,0)	Acco 202	Cost accounting for control	(3 0)
Chem 204	Biomolecules	(3.2)	Chem 205	Metabolic biochem.	(3.2)
	Total	(18,6)		Total	(18.6)

At the end of second year, student will be placed as a trainee in a recognized food processing/manufacturing industry for three summer months. Honorary examiners from the industry will be appointed to assess student performance.

Third Year

First Term			Second Term		
Biol 303	Basic microbiology and parasitology	(3.2)	Biol 304	Food microbiology	(3 2)
Food 303	Food science and Technology I	(3,2)	Food 304	Food Science and Technology II	(3 2)
	OR			OR	
Cate 303	Catering methods I	(3,2)	Cate 304	Catering methods II	(3.2)
Food 305	Food additives preservation. processing & packaging	(2,2)	Food 306	Food additives. preservation processing & packaging	(2,2)
Food 307	Nutrition II	(2.2)	Food 308	Nutrition & world food problem	(3.0)
Chem 306	Separation & methods of food analysis	(3 2)	Chem 307	Analysis & quality control of foods	(3 2)
				OR	
			Cate 305	Catering production analysis & quality cont.	(3,2)
Econ 303	Economic theory of the firm	(3 0)	Econ 304	Design. layout. planning. business forecasting. & feasibility studies	(3 0)
	Total	(16.10)		Total	(17 9)

At the end of third year, student will be placed as a trainee in a recognized hotel or food manufacturing industry for three summer months. Honorary examiners from the industry will be appointed to assess student performance.

Fourth Year

First Term

Food 409	Food science & Technology III	(3,2)
	OR	
Cate 406	Gastronomy I	(3,2)
Busi 401	Communications skills I Data processing	(3,2)
Busi 403	The manufacturing firm organizational models & case studies	(3.0)
	OR	
Cate 408	The catering firm, organizational models & case studies	(3,0)
Food 411	Fermentation studies	(3.0)
	OR	
Lang 401	Conversational French or German	(3,0)
Law 403	Food processing and catering laws, hygiene	(3 0)
Econ 305	Financial analysis & control	(3,0)
	Total	(15 6)

Second Term

Food 410	Food science & Technology IV	(3,2)
Cate 407	Gastronomy II	(3,2)
Busi 402	Communications Skills II record keeping. advt.	(3.2)
Busi 404	The manufacturing firm organizational models & case studies	(3 0)
	OR	
Cate 409	The catering firm, organizational models & case studies	(3,0)
Food 412	Food marketing - analysis and techniques	(3,0)
	OR	
Cate 410	Tourism. aesthetics & interior decorating	(3.0)
Law 404	Labour laws and personnel management	(3 0)
Food 413	Research project	(0,0)
	Total	(15.6)

7.2 ROLE OF BCIT*

1. PURPOSES OF THE *POLYTECHNIC*

1. *DEFINITION OF POLYTECHNIC*

A comprehensive institution dedicated to educating and training technicians and technologists to the certificate, diploma, and degree level. The programs offered are in response to the discerned needs of industry and business in the applied sciences of management, engineering and health.

2. ROLE

The role of the *Polytechnic* is to provide leadership in the field of technological education *particularly for British Columbia and, where appropriate, for Western Canada,* by effectively utilizing and continuously upgrading its specialized faculty and physical resources. *The Polytechnic's* continuing commitment is to:

(a) Train technologists and technicians in response to discerned needs of industry, business, government agencies and the professions;

(b) Provide programs, normally leading to a diploma of technology, which are appropriate to the segment of the community to be served by *the Polytechnic;*

(c) *Provide post diploma programs up to and including a Bachelor of Technology;*

(d) *Concentrate on programs which focus on the applied sciences of management, engineering, health, including inter-disciplinary training in these areas*

(e) *Provide similar related courses and programs for Continuing Education students on campus and throughout the Province;*

(f) *Develop advanced courses and programs where appropriate for the Diploma of Technology graduates and others with similar qualifications for the individual's further development;*

(g) Design, develop and deliver technological training tailored to meet the specific needs of employers and their employees, either locally or at a distance;

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* Adopted by the Board of Governors in December 1978.

(h) *Enhance the technological advancement of B.C. through the utilization of the human and technological resources of the Polytechnic in cooperation with appropriate agencies such as discovery park industries, and through applied research;*

(i) Attract well-qualified applicants who have demonstrated interest, a motivation to work, and an ability to undertake the intensive demands of post secondary education;

(j) Provide opportunities for students to acquire social, athletic and cultural experiences as preparation for the roles that complement the educational preparation of effective technologies;

(k) Provide leadership and service in technological education specifically, and to post secondary education generally to:

(i) determine and develop new programs in technological education and to keep existing programs current;

(ii) enter into appropriate student transfer programs with other post secondary institutions;

(iii) assist in the establishment and application of appropriate accreditation standards;

(iv) cooperate with other post secondary institutions through the sharing of information;

(v) provide a comprehensive talent resource of specialists in all subject areas;

(vi) encourage and develop innovative teaching methods;

(vii) demonstrate leadership through effective and efficient administrative practices appropriate to the management of *the Polytechnic;*

(viii) assist the Ministry of Education in particular and other Ministries in general on matters pertaining to technological education.

(l) Relative to the post secondary system *the Polytechnic's* role is to complement and yet be different from other post secondary institutions. *The Polytechnic* will maintain a complete breadth and depth of specialization, not only in facilities and equipment but more importantly in human resources and talent in the disciplines to be taught, and as such:

(i) provide a learning environment for students where

the orientation is *primarily* dedicated to technological education;

(ii) provide a comprehensive educational environment, closely linked with prospective employers of graduates, in which the faculty can draw upon the depth and breadth of technological and human resources of *the Polytechnic* to enable the development of programs to meet the challenges of technological education;

(iii) provide program models that are not necessarily exclusive to *the Polytechnic* and may be duplicated in whole or in part through the colleges where such programs are authorized by the designated council at the request of a college;

(iv) cooperate with colleges in the establishment of technological programs through the provision of consultative services; through the provision of course outlines, equipment and library lists; through encouragement of interchange of staff; through student transfer or through other arrangements.

(m) Maintain the provincial mandate by:

(i) addressing the discerned needs for technological education through the Province;

(ii) attracting students from all parts of the Province;

(iii) serving through distance education programs the technological education needs of citizens in all parts of British Columbia.

(n) *Serve Western Canada by:*

(i) offering specialized diploma programs where a discerned need is identified and as determined by the Council of Ministers;

(ii) offering advanced technology or business training beyond the diploma level to graduates of institutes of technology, colleges or universities in Western Canada.

3. DEFINITION OF DIPLOMA OF TECHNOLOGY

(a) The Diploma of Technology is awarded:

(i) upon successful completion of a program of approximately 2400 hours or equivalent of study beyond

high school graduation. Admission to these programs may frequently require special course or experience prerequisites;

(ii) to a student in full-time attendance who will normally complete a program in two to three years; a part-time student may take proportionately longer.

(b) Programs for the training and education of technologists prescribe a balance of applied theory and skills *through study on campus, complemented by supervised educational experience in industry and business, through such activities as clinical training, cooperative education, and/or equivalent work experience,* as necessary for employment in technological or para-professional/professional occupations including some curriculum which draws from advanced professional courses.

4. *DEFINITION OF A BACHELOR OF TECHNOLOGY*

(a) A Bachelor of Technology is awarded to a Diploma of Technology graduate or equivalent

(i) upon completion of approximately one year of supervised educational experience in industry and business, and

(ii) approximately 1200 hours or equivalent study beyond the Diploma of Technology, or equivalent.

(b) The program for training and education at the Bachelor of Technology level will include a balance of specialized technological theory and skills, complemented by study of relevant moral, social and political issues. This broadening of the individual's education will facilitate the development of insights, skills and values that are important to individual maturity and growth as a human being as well as a leader in society.

7.3 FINANCIAL ASSISTANCE PROGRAMS

a. Government of British Columbia Programs

British Columbia Development Corporation
Low Interest Loans Assistance (LILA)
Assistance to Small Enterprise Programme (ASEP)
Travel Industry Development Subsidiary Agreement
Agricultural & Rural Development Sub Agreement (ARDSA)
Technical Assistance Programme
Trade Show Assistance Programme
Trade Mission Programme
Market Development Assistance Programme
British Columbia Agricultural Credit Act
Farm Products Industry Improvement Act
Agricultural Land Development Act
British Columbia Income Assurance Programme
British Columbia Crop Insurance

Non Financial Assistance Programmes

Small Business Assistance Division (Ministry of Tourism & Small Bus. Dvpt.)
Thinking Exports
Farm Economics
Recreation Facilities Programme

b. Government of Canada Programs

BUSINESS FINANCING - Manufacturing, Processing and Service Industries

Business Financing, FBDB
Small Business Loans
Small Business Loans (YT)
Small Business Loans (NWT)
Indian Economic Development Fund
Eskimo Loan Fund
Export Loans - EDC
Export Credits Insurance and Guarantees - EDC
Foreign Investment Guarantees - EDC
Surety Risk Protection Insurance - EDC
Biomass Engergy Loan Guarantees
Housing Loans - CMHC
NWT Financial Assistance Programs
Residential Rehabilitation Assistance Programs

BUSINESS FINANCING - Primary Industries

Farm Improvement Loans
Farm Mortgage Loans - FCC
Farm Syndicate Loans - FCC
Crop Insurance
Advance Payment for Crops
Fisheries Improvement Loans
Fishing Vessels Insurance

GOVERNMENT CONTRIBUTIONS - Industrial Development Programs

Defence Industry Productivity, (DIP) Program
Enterprise Development Program (EDP)
Program for Export Market Development (PEMD)
Footwear and Tanning Industries Adjustment Program
Industrial Adjustment Assistance Program
Promotional Projects Program (PPP)

GOVERNMENT CONTRIBUTIONS - Regional Development Programs

Industrial Incentives Program (RDIA)
Canada - Newfoundland
Canada - Nova Scotia
Canada - New Brunswich
Canada - Quebec
Canada - Ontario
Canada - Manitoba
Canada - Saskatchewan
Canada - Alberta
Canada - British Columbia
Canada - PEI Comprehensive Development Plan
Montreal Special Area Program
SPECIAL ARDA
Cape Breton Development Corp.
Nfld. and Labrador Development Corporation

GOVERNMENT CONTRIBUTIONS - Research and Development Programs

Computer Assisted Design (CAD) - Building Design
Cooperative Projects with Industry (COPI)
Development and Demonstration of Resource and
Energy Conservation Technology (DRECT)

Forestry Research and Development
Heavy Oil Development
Industrial Post Doctoral Fellowships
Industrial Research Assistance Program (IRAP)
MINI-IRAP
Industry Energy Research and Development Program (IERD)
Low Energy Building Design Awards (LEBDA)
Oilspill Research and Development
Program for Industry/Laboratory Projects (PILP)
Program for Assistance to Solar Equipment
Manufacturers (PASEM)
Project Research Applicable to Industry (PRAI)
Protein, Oil and Starch Products Development
Renewable Energy and Conservation Demonstration Program
Scientific and Technology Employment Program
(STEP) and (STEPEX)
Strategic Grants in Aid of Research
Unsolicited Proposals for R&D
Waste Recycling and Recovery

GOVERNMENT CONTRIBUTIONS - Primary Industries Programs

Agricultural Commodities Price Stabilization
Dairy Support Program
Agricultural Fairs and Exhibitions Assistance
Agricultural Engineering R&D
Animal Disease Eradication
Canada Grains Council
Feed Grains Storage Assistance
Feed Freight Assistance Adjustment Fund
Feed Freight Assistance Program
Freight Charges Equalization - Flour for Export
Grain Market Development (CIGI)
Income Stabilization - Grain Producers
New Crop Development Fund
Prairie Farm Rehabilitation Administration (PFRA)
Assistance to Rapeseed Producers
Rapeseed Products (RUAP)
Aquatic Weeds, R&D
Canadian Saltfish Corp.
Fish Chilling Facilities
Fisheries Research Support
Fishing Vessel Construction Assistance
Grants to Atlantic Salmon and Lobster Fishermen
Price Support for Fish
Salmonid Enhancement Program (SEP)
Engergy from the Forest Program (ENFOR)
Forest Industry Renewable Energy (FIRE)
Prospectors' Assistance

GOVERNMENT CONTRIBUTIONS - Manpower Programs

Canada Manpower Consultative Service
Canada Manpower Industrial Training Program
Canada Manpower Training Program
Critical Trade Skills Training (CTST)
Small Business Intern Program
Canada Manpower Mobility Program
Agricultural Workers

GOVERNMENT CONTRIBUTIONS - Miscellaneous Programs

Book Publishing Development Program
Business Councils
Canada Council Grants
Energy Systems Analysis
Design Assistance to Business
Fashion Design Assistance Program (FDAP)
Foreign Investment Assistance - Developing Countries (CIDA)
Film Industry Assistance
Grants to International Film Festivals in Canada
Participation in Film Festivals Abroad
Home Insulation Assistance (CHIP)
Home Insulation Assistance (HIP)
Labour Education
Northern Resources Roads Assistance
Purchase and Use of Solar Heating (PUSH)
Shipbuilding Assistance
Small Craft Harbours
Marina Assistance Program
Tourist Wharf Program
Workers' Tools - Metric Conversion Assistance
Oil Import Compensation Payments
Transportation Subsidies
Assisted Rental Programs

INFORMATION AND SERVICES

Market Development

Canadian Commercial Corp.
Exports to Developing Countries (CIDA)
Import Analysis
Industry Sector Branches
Inter-Firm Comparisons
Physical Distribution Advisory Services
International Bureaux - Service for Exporters
International Trade Data Bank
Master Construction Specifications (GMS)
Overseas Projects Office - Exports Assistance (Directory)
Selling to Government
Tourism Industry Assistance
Trade Commissioner Service

Research and Development

Canada Institute for Scientific and Technical Information (CISTI)
Industrial Research Associations
Industrial Research Institutes
Centres for Advanced Technology
Industrial Innovation Centres
Scientific and Technical Services (NRC)
Space Industry Support
Technical Information Service (TIS)
Technology Transfer (AECL)
Wastewater Technology Centre

Primary Industries

Agriculture Information Service
Farm Building Plans Service
Fish Inspection Services
Fisheries Market Information and Services
Freshwater Fish Marketing Corp.
Forestry Services
Canadian Hydrographic Service
Energy Waste Detection - Energy Bus Program
Exploration and Mining Services

Geoscience Information
Land Inventory and Land Use Management
Mineral and Energy Research Development Services - CANMET
Natural Resource Services Information
Remote Sensing
Water Management Data
Water Management Programs

Manpower and Management Development

Collective Bargaining Information Centre
Employment Services
Federal Mediation and Conciliation Service
Interchange Canada Program
Labour Library and Information Services
Management Counselling - CASE
Management Improvement
Management Training for Small Business
Quality of Working Life Program
Small Business Information Service
Unemployment Insurance Information

General Programs

Bankruptcy
Business Statistics
Canada Post Publications and Business Services
Competition
Copyright Industrial Design
Health Protection Services
Incorporation
Inventors' Assistance (CPDL)
Metric Conversion
Paperburden
Patents
Standardization
Surplus Equipment
Technical Services for Film Production
Trade Marks
Weather Information Services

7.4 BIBLIOGRAPHY

Traditional approach to entrepreneurial education has been to train students in small-business management. Most of the references given below reflect this traditional thinking. To the best of our knowledge, entrepreneurial education as an integrated educational and economic development program to generate high-technology industry, is a novel concept. Consequently, literature on such a concept is unavailable. References to a few programs in which engineering graduates are given business management training are included in this bibliography.

General references given in Section A have been particularly useful in the preparation of this report. Texts listed in Section B provide material for a course in entrepreneurship (e.g. Organizational Development - How to Start, Finance and Manage, - Year 3, Term 8 of the proposed education program, page 45).

A. General References

1. Gustafson, R. "An Entrepreneurial Spirit", Mechanical Engineering News, Vol. 5, No. 4. Nov. 1968, P. 5.

2. Vesper, K. "Two Approaches to University Stimulation of Entrepreneurship", Technical Entrepreneurship, Center for Venture Management, Milwaukee, Wisconsin, 1972.

3. Wagner, G. and Bright, J. "Technical Entrepreneurship for Engineering Seniors", Working Paper, University of Texas, 1973.

4. Roscow, J. "Can Entrepreneurship be Taught", MBA Magazine, June 1973, P. 16.

5. Conference Board in Canada - "Are Today's Schools Preparing Tomorrow's Business Leaders?", 1974.

6. Proceedings of International Symposium on Entrepreneurship and Enterprise Development, Summer, 1975.

7. Atlantic Management Study - A Report for the Government of Canada - December 1976.

8. Vesper, K. Entrepreneurship Education - A Bicentennial Compendium, Society for Entrepreneurship Research and Application, Milwaukee, Wisconsin, 1976.

9. Davenport, P. Capital Accumulation and Economic Growth, Ph.D. Dissertation, Department of Political Economy, University of Toronto, 1976.

10. Living Together: A Study of Regional Disparities, Economic Council of Canada, Supply and Services Canada, Ottawa, 1977.

11. Peterson, R. Small Business: Building a Balanced Economy, York University, 1977.

12. Brousson, D. Entrepreneurial Education and a Small-Business Institute - A Report for Vancouver Kiwanis Club and Vancouver Community College, 1977.

13. Cooperative Education: Entrepreneurial Development by Colleges and Universities, Bibliography, Phelps-Stokes Fund, Washington, D.C., June 1977.

14. Kramer, F. Cooperative Education: Entrepreneurial Development by Colleges and Universities. A Case, etc. . ., Phelps-Stokes Fund, Washington, D.C., Vol. 1 Nov. 1977, Vol. 2 Dec. 1977.

15. Britton, J. and Gilmour, J. The Weakest Link, Science Council of Canada, Ottawa, 1978.

16. A Feasibility Study for a Skills Center Concept, Merced County Department of Education, California, 1978.

17. Numerous Publications of:

    a. Ministry of Industry, Trade and Commerce, Government of Canada.

    b. Department of Regional Economic Expansion, Government of Canada.

    c. Canada Employment and Immigration Commission.

    d. Ministry of Economic Development, Government of British Columbia.

    e. Small Business Administration, Government of the United States of America.

B. Texts on Entrepreneurship

1. Klatt, L. Managing the Dynamic Small Firm, Wadsworth, Belmont, Ca., 1971.

2. Slocum, D. New Venture Methodology, Am. Man. Assn. Yew York, N.Y., 1972.

3. Klatt, L. Small Business Management: Essentials of Entrepreneurship, Wadsworth, Belmont, Ca., 1973.

4. Baty, G. Entrepreneurship: Playing to Win, Reston Press, Reston, Va., 1974.

5. Liles, P. New Business Ventures and Entrepreneur, R.D. Irwin, Inc., Homewood, Ill., 1974.

6. Mancuso, J. Entrepreneur's Handbook, 2 vols., Artech House, Dedham, Ma., 1974.

7. Baumback, C. and Mancuso, J. Entrepreneurship and Venture Management, Prentice Hall, Englewood Cliffs, N.J., 1975.

8. Morrison, R. Handbook for Manufacturing Entrepreneurs, Western Reserve Press, Ashtabula, Ohio, 1975.

9. Stanford, M. New Enterprise Management, Brigham U. Press, Provo, Utah, 1975.

10. Buskirk, R. and Vaughan, P. Managing New Enterprise, West. Pub., St. Paul, Minn., 1976.

11. Cifton, D. and Fyffe, D. Project Feasibility Analysis: A Guide to Profitable New Ventures, Wiley, New York, N.Y., 1977.

12. Timmons, J. New Venture Creation, R.D. Irwin, Inc., Homewood, Ill., 1977.

13. Broom, H. and Longenecker, J. Small Business Management, 4th Ed., South-West Pub., Cincinnati, Ohio, 1978.

14. Stienhoff, D. Small Business Management Fundamentals, 2nd Ed., Davis Keith (Ed.), McGraw-Hill, New York, N.Y., 1978.